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TWELFTH ANNUAL REPORT

OF THE

BOARD OF CONTROL

OF THE

STATE AGRICULTURAL EXPERIMENT STATION

AT

AMHERST, MASS.

1894.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
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1895.

HARVARD UNIVERSITY
FEB 20 1945
GRADUATE SCHOOL
OF PUBLIC ADMINISTRATION

Commonwealth of Massachusetts.

Boston, Jan. 10, 1895.

To the Honorable Senate and House of Representatives.

In accordance with chapter 212 of the Acts of 1882 I have the honor to present the Twelfth Annual Report of the Board of Control of the State Agricultural Experiment Station.

WM. R. SESSIONS,
Secretary.

MASSACHUSETTS STATE

AGRICULTURAL EXPERIMENT STATION,

AMHERST, MASS.

BOARD OF CONTROL, 1894.

His Excellency Frederic T. Greenhalge,
Governor of the Commonwealth, President ex officio.

W. H. Bowker of Boston, ... Term expires, 1895.
C. L. Hartshorn of Worcester, ... Term expires, 1897.
Appointed by the State Board of Agriculture.

J. H. Demond of Northampton, ... Term expires, 1896.
E. D. Howe of Marlborough, ... Term expires, 1896.
Appointed by the Board of Trustees of the Massachusetts Agricultural College.

F. H. Appleton of Peabody, ... Term expires, 1897.
Appointed by the Massachusetts Society for Promoting Agriculture.

W. H. Porter of Agawam, ... Term expires, 1895.
Appointed by the Massachusetts State Grange.

Wm. C. Strong of Newton Highlands, . . Term expires, 1897.
Appointed by the Massachusetts Horticultural Society.

H. H. Goodell, A.M., LL.D., Amherst,
President of the Massachusetts Agricultural College.

C. A. Goessmann, Ph.D., LL.D., Amherst,
Director of the Station.

Wm. R. Sessions, Hampden,
Secretary of the State Board of Agriculture.

OFFICERS ELECTED BY THE BOARD.

H. H. Goodell, Amherst,
Vice President.

Wm. R. Sessions, Hampden,
Secretary and Auditor.

C. A. Goessmann, Amherst,
Treasurer.

STATION STAFF.

C. A. GOESSMANN, Ph.D., LL.D., *Director and Chemist*, . . Amherst.
J. B. LINDSEY, Ph.D., *Associate Chemist* (*Feeding Department*), . Amherst.

ASSISTANTS.

C. S. CROCKER, B.S., .	*General and Analytical Chemistry.*
H. D. HASKINS, B.S., .	" " "
C. H. JONES, B.S., .	" " "
F. L. ARNOLD, B.S., .	" " "
C. H. JOHNSON, B.S., .	" " "
E. B. HOLLAND, B.S., .	*Assistant Chemist in Feeding Experiments.*
R. H. SMITH, B.S., .	" " " "
L. E. GOESSMANN,*. .	*Assistant Chemist and Clerk.*
DAVID WENTZELL, . .	*Farmer.*

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* Resigned July 1, 1894.

TWELFTH ANNUAL REPORT OF THE DIRECTOR

OF THE

MASSACHUSETTS STATE AGRICULTURAL EXPERIMENT STATION,

AMHERST, MASS.

To the Honorable Board of Control.

GENTLEMEN: — The different lines of investigation decided upon in preceding years have been pursued during the past year. No material changes have been introduced in regard to the general character of the work assigned. The different plans for the experiments presented from time to time at the quarterly meetings for your endorsement have been carried out as far as practicable to the full extent of the means at hand. The results obtained in this connection compare well with those of preceding years. The advanced stage of some of the experiments imparts to the results obtained for obvious reasons from year to year an increased interest, and may claim for our reports a due consideration on the part of our farming community as well as students of agricultural progress in general.

The feeding experiments with different kinds of farm live stock, inaugurated soon after the establishment of the Experiment Station, have received ever since most careful attention. The inquiries into the economy of substituting several reputed forage crops, new to our section of the country, for meadow hay in the daily diet of milch cows, have been continued during the past year with much success. Several new kinds of waste products of corn (maize) and other grains have been tested with reference to their degree of fitness to serve as ingredients in efficient grain rations for different kinds of farm live stock. Much work has been accomplished in connection with the use of the Babcock apparatus for the determination of fat in milk and cream.

The question of using skim milk supplemented in various ways for the production of veal has been studied in a series of experiments with calves.

The digestion experiments with sheep, for the purpose of ascertaining the rate of digestibility of the various food constituents of some new coarse and fine feed stuffs peculiar to our markets, have been materially increased in number. The detailed record of these and other observations of interest in this connection, which have been under the special supervision of Dr. J. B. Lindsey, associate chemist of the Experiment Station, furnishes the first part of the accompanying annual report, under the following headings: —

PART I.

FEEDING EXPERIMENTS.

I. A practical talk about feeding.
II. Objects of the different experiments.
III. Feeding experiments with milch cows (two).
IV. Hay substitutes.
V. The Babcock *v.* the space system, etc.
VI. Feeding experiment with steers.
VII. Feeding calves for veal.
VIII. Digestion experiments.
    1. Digestion experiments with sheep.
    2. The digestibility of the pentosans.

The experiments in the field and in the vegetation house have been quite numerous and of a varying character. Some of them are a continuation of those of former years, while others are new. Much attention has been devoted to the raising of nutritious forage crops fit for green fodder, hay and ensilage; the results are gratifying, and cannot fail to exert a desirable influence on the future supply of coarse fodder for farm live stock, as far as quantity as well as cost of production and valuable composition is concerned. The good success noticed in the field during the first part of the summer season was in some instances seriously checked by a severe drought during the month of August. A description of the different experiments carried on in this connection by the writer forms the second part of the succeeding annual report, under the following-named headings: —

PART II.

FIELD EXPERIMENTS.

1. Field experiments for the purpose of studying the economy of raising leguminous plants (clover, etc.) as a means of enriching the soil in nitrogen in the interest of the subsequent raising of grain crops (Field A).
2. Field experiments with several prominent varieties of potatoes and some prominent mixed forage crops (Field B).
3. Field experiments to ascertain the influence of different mixtures of commercial fertilizers on the yield and general character of several prominent garden crops (Field C).
4. Experiments with forage crops (27), to study their fitness for our climate (Field D).
5. Trial of an early maturing variety of Minnesota dent corn (Field E).
6. Field experiments with different commercial phosphates, to study the economy of using the cheaper natural phosphates or the more costly acidulated phosphates (Field F).
7. Experiments with forage crops (vetch and oats and Hungarian grass, Field G).
8. Field experiments to study the effect of phosphatic slag and nitrate of soda as compared with ground bone on the yield of oats and corn (east field).
9. Experiments with permanent grass lands (meadows).
10. Orchard. Experiments with home-made stable manure, unleached wood ashes and several mixtures of fertilizing materials on the growth and yield of several varieties of fruit trees.
11. Observations in the vegetation house.
12. Report on general farm work.

The work in the chemical laboratory of the station is steadily increasing. The progress of the work in the field, the barn and the vegetation house in some cases calls for much analytical chemical work, and the applications of the citizens of the State for free analyses of fodders, fertilizers, well water and a variety of waste products are from year to year more numerous. The amount and character of the work in the chemical laboratory may be judged from the following statement, which represents the third part of the report: —

PART III.

SPECIAL WORK IN THE CHEMICAL LABORATORY.

I. Communication on commercial fertilizers: —

1. General introduction.
2. State laws for the regulation of the trade in commercial fertilizers.
3. List of licensed manufacturers and dealers from May 1, 1894, to May 1, 1895 (58).
4. Analyses of licensed fertilizers (253).
5. Analyses of commercial fertilizers and manurial substances sent on for examination (145).
6. Miscellaneous analyses (4).
7. Miscellaneous fodder analyses (69).

The chemical analyses made in connection with investigations carried on at the station are reported in the description of the work.

II. Analyses of milk sent on for examination (40).
III. Analyses of water sent on for examination (200).
IV. Compilation of analyses made at Amherst, Mass., of agricultural chemicals and refuse substances used for fertilizing purposes.
V. Compilation of analyses made at Amherst, Mass., of fodder articles, fruits, sugar-producing plants, dairy products, etc.
VI. Table of digestibility of American feed stuffs.

The weather observations for local purposes have been continued, and copies of our records have been regularly sent to the United States department, according to directions. The periodically published bulletins have been as many as in previous years. The number of regular applicants for copies is increasing. The supply of copies of previous years is in many cases exhausted.

The condition of the buildings pointed out in my preceding report has not been changed; some of the farm buildings need repairing of roofs and repainting. The laboratory buildings (brick) are in a fair condition; their outfit has not been materially increased, for economical reasons.

In concluding, it gives me particular pleasure to acknowledge the satisfactory assistance I have enjoyed from all parties associated with me in carrying out the work assigned. Thanking you for the kind consideration received in the past, I am,

Yours very respectfully,

C. A. GOESSMANN,

Director.

AMHERST, MASS., Jan. 1, 1895.

ANNUAL REPORT OF C. A. GOESSMANN,

TREASURER OF THE MASSACHUSETTS STATE AGRICULTURAL EXPERIMENT STATION,

For the Year ending Dec. 20, 1894.

RECEIVED.		
Cash on hand from last year,	$252 65	
Cash from State Treasurer, appropriation,	10,000 00	
Cash from fertilizer account,	3,090 00	
Cash from dairy bureau,	11 00	
Cash from farm,	1,153 42	
Cash from miscellaneous sources,	79 95	
		$14,587 02
EXPENDED.		
Cash paid salaries,	$4,287 18	
Cash paid laboratory supplies,	660 79	
Cash paid printing and office expenses,	887 63	
Cash paid farmer and farm labor,	2,379 84	
Cash paid farm supplies,	1,764 24	
Cash paid fertilizer account,	3,090 00	
Cash paid construction and repairs,	544 50	
Cash paid expense of Board of Control,	90 54	
Cash paid incidental expenses,	382 92	
Cash paid library,	277 84	
Cash on hand,	221 54	
		$14,587 02

SUMMARY OF THE PROPERTY OF THE MASSACHUSETTS STATE AGRICULTURAL EXPERIMENT STATION (DEC. 20, 1894).

Live stock,	$645 00	
Tools, implements and machinery,	843 90	
Produce on hand,	364 00	
Fertilizers,	196 00	
Laboratory inventory,	3,500 00	
Office furniture, library, etc.,	2,095 00	
Furniture, herbariums, library and collections,	1,300 00	
Photographic supplies,	150 00	
Greenhouse apparatus,	200 00	
Mycologists' apparatus,	350 00	
Chemical apparatus and supplies,	300 00	
Buildings, land, etc.,	30,570 00	
		$40,513 90

This is to certify that I have examined the books and accounts of Charles A. Goessmann, treasurer of the Massachusetts Agricultural Experiment Station, for the fiscal year ending Dec. 20, 1894, and find them correct, and all disbursements properly vouched for, with a balance in the treasury of two hundred and twenty-one fifty-four one-hundredths dollars, which is shown to be in the bank.

WM. R. SESSIONS,
Auditor.

JAN. 15, 1895.

PART I.

FEEDING EXPERIMENTS

AND

DAIRY STUDIES.

BY J. B. LINDSEY.

I. A Practical Talk about Feeding.
II. Objects of the Different Experiments.
III. Feeding Experiments with Milch Cows (two).
IV. Hay Substitutes.
V. The Babcock *v.* the Space System, etc.
VI. Feeding Experiment with Steers.
VII. Feeding Calves for Veal.
VIII. Digestion Experiments.
  1. Digestion Experiments with Sheep.
  2. The Digestibility of the Pentosans.

I.

1. A BRIEF PRACTICAL TALK ABOUT SOME OF THE PRINCIPLES INVOLVED IN FEEDING OUR FARM ANIMALS.

In order to feed the live stock of the farm to the best advantage, it is important that the farmer be familiar with the elementary principles of animal nutrition.

Now the body of the animal is made up, generally speaking, of four distinct groups of substances, namely, (1) water, (2) flesh (lean meat), (3) fat, (4) ash.

The percentage of water in different animals in different stages of growth varies in round numbers from 40 to 85 per cent.; the percentage of bone framework of the body from 6 to 12 per cent.; the flesh, not including blood and entrails, composes from 30 to 48 per cent.; while the fat varies from 5 to 40 per cent.

An average composition of the various farm animals would be somewhat as follows: bones, 8.9 per cent.; flesh and teeth, 40.1 per cent.; fat that can be removed by mechanical means, 23.9 per cent.; and blood, hair, horns, entrails, including foods contained therein, 27.1 per cent.

The milk, an animal product, contains approximately 87 per cent. of water, 3.5 per cent. of casein and albumen or nitrogenous matter, of which the lean meat of the animal is also a type, 0.7 per cent. of ash and about 8.5 per cent. of fat and milk sugar.

The flesh or lean meat is composed of nitrogen, carbon, hydrogen, oxygen, sulphur and phosphorous; its characteristic element is the nitrogen. Small quantities of ash also enter into its composition. The bones are made up partly of nitrogenous matter, such as glue, gelatine, etc., partly of fat and partly of ash. The ash or earthy part of the bone, as some call it, is composed principally of phosphate of lime. The fat contains no nitrogen, but has as high as 76 per cent. of carbon, the balance consisting of oxygen and hydrogen.

The ash constituents of the body consists essentially of lime, potash, soda, magnesia, iron, phosphoric acid and sulphuric acid. The phosphate of lime predominates.

Now, these various substances, making up the animal body, — flesh, fat, ash and water, — are formed or obtained direct with the aid of the oxygen of the air from the substances termed foods that the animal consumes. Our neat stock, for example, consume the various coarse fodders and grains and have the power within them of converting these vegetable foods into flesh, fat and bone.

Recognizing, then, the composition of the animal body, both as regards its groups of substances and the more elementary substances that make up these groups, let us turn our attention to a brief study of the foods from which the body is built up.

CLASSIFICATION AND COMPOSITION OF CATTLE FOODS.

(*a*) *Classification.*

For our purpose cattle foods may divide into: (1) coarse fodders, (*a*) those rich in carbohydrates (cellular matter, starch, etc.) and low in protein, and about 50 to 65 per cent. digestible, (*b*) the legumes when cut in bloom, rich in protein and about as digestible as (*a*); (2) root crops, also rich in carbohydrates and low in protein, but very digestible; (3) concentrated foods with a digestibility of from 75 to 85 per cent. The concentrated foods should be subdivided into (*a*) those rich in carbohydrates and comparatively low in protein, such as wheat, rye, barley, oats and corn; and (*b*) those that are rich in protein and comparatively low in carbohydrates, as peas, beans, gluten feeds and meals, cotton-seed meal, linseed meals, peanut meal, etc.

Table of Classification.

COARSE FOODS.		ROOTS.	CONCENTRATED FOODS.	
(*a*)	(*b*)		(*a*)	(*b*)
Low in protein, high in carbohydrates; 50-65 per cent. digestible.	**High in protein, medium in carbohydrates; 50-65 per cent. digestible.**	**Low in protein, rich in carbohydrates; very digestible.**	**Low in protein, high in carbohydrates; 75-85 per cent. digestible.**	**Very high in protein, low in carbohydrates; 75-85 per cent. digestible.**
Hays of various grasses, straws, corn fodder, corn straw, corn ensilage.	**Clovers, peas, beans, soya bean, vetches, serradella, etc.**	**Mangolds, sugar beets, turnips, potatoes, carrots, etc.**	**Wheat, rye, barley, oats, corn.**	**Pea and bean meal, gluten feeds and meals, cottonseed meal, linseed meals, peanut meals, etc.**

(*b*) *Composition.*

All of our cattle foods have been divided into five groups of substances: (1) crude ash, (2) crude cellulose, (3) crude fat, (4) crude protein, (5) extract matter. Water is always present, and might be called a sixth group.

Each one of the first five groups can be resolved into more simple substances. With some of the substances or compounds making up the groups we have only a partial knowledge.

(*1*) *Crude Ash.*

By crude ash is meant the mineral ingredients of the plant or seed remaining behind after the organic portion has been destroyed by fire. The ash or ashes of a plant consist essentially of lime, potash, soda, magnesia, iron, phosphoric acid, sulphuric acid, etc.

Functions of the Ash. — It is these various mineral ingredients that serve to build up the bony structure of the animal; they also enter into and are necessary components of the flesh itself.

(*2*) *Crude Cellulose.*

The crude cellulose is the coarse or woody part of the plant; we may term it the framework of the plant. Its elementary composition is carbon, oxygen, hydrogen and a small percentage of ash. The crude cellulose is largely present in straws and hays; the various grains, on the other hand, contain but a small percentage. Cows, oxen, sheep and horses have a digestive tract so arranged as to be able to consume and digest large quantities of such coarse fodders.

Functions of the Cellulose. — It cannot form flesh, but serves to produce vital energy and fat.

(3) *Crude Fat.*

By crude fat is meant not only the fats and oils found in the various foods, but also the waxes, resins, etc. It has also been termed "ether extract," because it is that portion of the plant soluble in ether. Its elementary composition is carbon, oxygen and hydrogen, with a much higher percentage of carbon than either the cellulose or extract matter.

Functions of the Fat. — It serves the same purposes as the cellulose; it furnishes, however, two and one-half times as much heat or energy as the cellulose.

(4) *Crude Protein.*

Protein is a general name for all the nitrogen-containing bodies found in our common agricultural plants. It might be called "vegetable meat." It corresponds, generally speaking, to the lean meat of the animal body. All protein or albuminoids contain on an average about 16.5 per cent. of nitrogen. It is, other things being equal, the most valuable food constituent of the plant. Its elementary composition is carbon, nitrogen, oxygen, hydrogen, phosphorus and sulphur.

Functions of the Protein. — The protein is a source of energy, and is *the only source of flesh.* It also has been considered a source of fat, although much doubt has lately been thrown upon this idea.

(5) *Extract Matter.*

The so-called non-nitrogenous extract matter consists of the starch, sugars and gums. A large part of the extract matter of the coarse fodders (one-third to one-half) consists of the wood gums or pentosans. It has been shown that in the majority of cases the pentosans are as valuable for food as other carbohydrates. The elementary composition of the extract matter is carbon, oxygen and hydrogen.

Functions of the Extract Matter.—The sugars, starch and gums furnish energy, and serve as sources of fat. The crude cellulose and the extract matter, having the same functions in the animal economy, namely, the production of energy and fat, have been termed carbohydrates. The ash, while a necessary ingredient of all complete foods for live stock, is not generally considered in compounding suitable daily diets for our farm animals; so that, for practical purposes, we really have to do with but three groups: (1) protein, (2) carbohydrates, (3) fat.

Having noted the different groups of substances of which our agricultural plants are composed, let us briefly turn our attention to the value of these groups as sources of nourishment. No one of them is of itself a suitable food for our farm animals, nor will any one of them sustain life for any length of time.

DIGESTIBILITY OF CATTLE FOODS.

Foods are valuable as sources of nourishment only in so far as their various constituents or groups can be digested and assimilated. Two kinds of hay, one early and the other late cut, might be consumed in equal quantities by an animal, yet the early cut hay, having more digestible matter, would prove the more valuable fodder. In order to combine the various fodders into what has been termed a fodder ration, it is important to know how large a part or per cent. of the various groups is digestible. A great many digestion experiments have been made with various cattle foods, especially in Germany; during the last six or seven years a considerable number have been carried out in the United States. A tabulated list of all American experiments will be found at the end of this report.

How the Digestible Matter of a Food is determined.

First ascertain the amount and composition of the food consumed by an animal in a given length of time, also the amount and composition of the fæces or undigested portion excreted in the same time on the basis of dry matter. The difference between them will represent the amount of the various constituents of the food digested.

The percentages of the constituents digested are called the digestion coefficients.

A Single Illustration, showing how the Digestibility of a Fodder is determined.

[Solid manure equals the undigested part of food.]

English Hay.

	Dry Matter (Grams).	Crude Cellulose (Grams).	Crude Fat (Grams).	Crude Protein (Grams).	Extract Matter (Grams)
900 grams hay fed, equal to . . .	765.36	250.58	23.57	82.58	348.09
369.3 grams manure excreted, equal to	337.95	107.00	12.81	34.64	145.89
Amount of hay digested, . .	427.41	143.58	10.76	47.94	202.80
Per cent. digested, ...	55.84	57.30	45.65	58.05	58.16

Having noted the various groups of substances going to make up our cattle foods, and recognizing that these groups are valuable as sources of nourishment only in so far as they are digestible, let us next inquire into the *proper way of combining these foods*, so as to produce properly balanced daily diets or

FODDER RATIONS FOR THE ANIMALS OF THE FARM.

A great many experiments have been made in order to study the behavior of the protein, carbohydrates and fat in the animal body, and their specific influences upon the formation of flesh, fat and milk. We will not attempt in this connection to give in detail the results of these studies, but simply state that they have led to the combining of our coarse and concentrated foods in such a way as to obtain in the daily diet of the animal the digestible protein, fat and carbohydrates in certain reasonably definite proportions.

The German investigator Wolff, who has made a close study of all experiments along this line, has concluded that a milch cow, for example, in order to produce a large and well-sustained yield of milk, should be fed about 2.5 pounds of digestible protein, .5 pound of digestible fat and 13 pounds of digestible carbohydrates daily, on the basis of 1,000 pounds live weight. In preparing fodder rations for milch cows, then, it should be our aim to so combine the coarse and concentrated foods as to obtain these groups in the approximately correct proportions. Variety and palatability of food must also be taken into consideration.

How Fodder Rations are made up.

In order to show how fodder rations are put together, we will construct one from English hay, corn meal, cotton-seed meal and wheat bran. We must know (1) the analyses of the fodders and (2) their digestibility. These data are to be found in the table following: —

Table showing Composition and Digestibility.

	ENGLISH HAY.		CORN MEAL.		COTTON-SEED MEAL.		WHEAT BRAN.	
	Composition.	Per Cent. Digestible.	Composition.	Per Cent. Digestible.	Composition.	Per Cent. Digestible.	Composition.	Per Cent. Digestible.
Moisture, ...	15.00	-	14.00	-	7.00	-	10.00	-
Dry matter, ...	85.00	-	86.00	-	93.00	-	90.00	-
	100.00	-	100.00	-	100.00	-	100.00	-
Dry matter contains: —								
Crude ash, ...	6.20	notdet.	1.62	notdet.	7.30	notdet.	7.50	notdet.
" cellulose, ...	31.00	60	2.15	77	7.70	-	11.00	25
" fat, ...	2.80	49	3.83	85	12.00	97	5.00	72
" protein, ...	10.00	60	11.00	72	44.00	88	18.00	78
Extract matter, ...	50.00	60	81.40	94	29.00	64	58.50	68
	100.00	-	100 00	-	100.00	-	100.00	-

The average composition and the average per cent. digestible of all cattle foods are to be found in tables at the end of this report.

Rules for compounding Properly Balanced Fodder Rations.

1. A milch cow of 1,000 pounds live weight needs approximately 2.5 pounds of digestible protein, .5 to .75 pound of digestible fat and 13 pounds of digestible carbohydrates daily.

2. Calculate the rations on the basis of 1,000 pounds live weight. Cows weighing but 700 to 800 pounds will need only seven-tenths or eight-tenths as much. (This is not always true. Example: very thin cows fresh in milk would need rather more, and cows in fair to good condition towards the end of lactation less.)

3. Use 21 pounds of English hay or its equivalent of some other coarse fodder as a basis. (This will furnish 1 pound of digestible protein, and it is now necessary to make up the necessary amount of protein by the addition of concentrated fodders. In doing this the necessary carbohydrates not furnished by the hay will also be added.)

4. Use 8 to 10 pounds of two or three different grains, about one-third of each kind. (Not over 3 pounds of corn meal should be added. The various gluten feeds can often take the place of corn meal to advantage. It is almost always economical to use 3 pounds of bran. As the third grain 2 to 3 pounds of one very high in protein should be used, such as cotton-seed meal, or one of the gluten or linseed meals.)

5. Reduce the quantity of each of the substances to be fed *to dry matter*, by multiplying by the *average per cent. of dry matter* in such substances, as found in the tables.

6. Multiply the amount of dry matter in each of the foods by the average percentages of cellulose, fat, protein and extract matter it contains, and these products by the *digestion percentages* of these same groups. The last products will be the amount of digestible cellulose, fat, protein and extract matter contained in each of the several foods. Add the several digestible amounts as found in the various foods together, and the sum will be the total digestible cellulose, fat, protein and extract matter in all of the feeds going to make up the daily ration.

7. To calculate the nutritive ratio of the ration, multiply the amount of digestible fat by 2½, and add the product to the digestible cellulose and extract matter; divide this sum by the digestible protein, and the dividend will be the ratio required.

A Practical Example.

Fodder Ration for a Milch Cow of 1,000 Pounds Live Weight.

	Digestible.			
	Protein.	Fat.	Carbohydrates.	Total.
	Pounds.	Pounds.	Pounds.	Pounds.
Needed, ...	2.50	0.50	13.00	16.00

Ration shall be composed of: —

21 pounds English hay.	3 pounds cotton-seed meal.
3 pounds corn meal.	3 pounds wheat bran.

	Fodders.			Fodder Constituents.			
	Pounds as Fed.	Per Cent. Dry Matter therein.	Pounds Dry Matter.	Per Cent	Pounds.	Per Cent. Digestible.	Pounds Digestible.
				(a) Cellulose.			
Hay, ...	21×	85=	17.85×	31.00=	5.53×	60=	3.31
Corn meal, ...	3×	86=	2.60×	2.15=	0.06×	77=	0.05
Cotton-seed meal, ...	3×	93=	2.80×	7.70=	0.22×	00=	0.00
Wheat bran, ...	3×	90=	2.70×	11.00=	0.30×	25=	0.07
Total, ...	.	.	. .	. .	. .	.	3.43
				(b) Fat.			
Hay, ...	21×	85=	17.85×	2.80=	0.50×	49=	0.25
Corn meal, ...	3×	86=	2.60×	3.83=	0.10×	89=	0.09
Cotton-seed meal, ...	3×	93=	2.80×	12.00=	0.34×	88=	0.30
Wheat bran, ...	3×	90=	2.70×	5.00=	0.13×	72=	0.09
Total, ...	.	.	. .	. .	. .	.	0.73
				(c) Protein.			
Hay, ...	21×	85=	17.85×	10.00=	1.78×	60=	1.07
Corn meal, ...	3×	86=	2.60×	11.00=	0.29×	72=	0.21
Cotton-seed meal, ...	3×	93=	2.80×	44.00=	1.23×	85=	1.04
Wheat bran, ...	3×	90=	2.70×	18.00=	0.49×	78=	0.38
Total, ...	.	.	.	. .	. .	.	2.70
				(d) Extract Matter.			
Hay, ...	21×	85=	17.85×	50.00=	8.92×	60=	5.35
Corn meal, ...	3×	86=	2.60×	81.40=	2.11×	94=	1.98
Cotton-seed meal, ...	3×	93=	2.80×	29.00=	0.81×	95=	0.77
Wheat bran, ...	3×	90=	2.70×	58.50=	1.58×	68=	1.07
Total, ...	.	.	. .	. .	. .	.	9.17

Summary.

	Pounds.
Total digestible protein,	2.70
Total digestible fat,	0.73
Total digestible cellulose and extract (carbohydrates),	12.60
Total digestible organic nutrients,	16.03

These figures correspond very closely with the amounts required (see top of page 22).

Calculating the Nutritive Ratio.

	Pounds.
Carbohydrates,	12.60
Fat, .73 pound × 2¼ =	1.82
Total,	14.42

14.42 pounds carbohydrates ÷ 2.7 pounds protein = 5.34, or as 1 protein is to 5.34 carbohydrates (1 : 5.34).

The Real Meaning of Nutritive Ratio.

Nutritive ratio is simply the numerical relation which the fat and carbohydrates bear to the protein which is taken as unity; or, stated in the form of a problem, how many more units of carbohydrates and fat reduced to carbohydrates are present in the ration than units of protein?

It has been demonstrated by experiment that, other things being equal, the best returns can be secured in case of milch cows, for example, if the various fodders are so combined as to produce a ration containing 4.5 to 5.5 times as much carbohydrates as protein; or, in other words, rations having a nutritive ratio of 1 : 4.5 to 5.5.

While this proportion should be kept in mind in making up the fodder ration, palatability and variety should by no means be lost sight of.

Rations with a nutritive ratio of 1 : 4.5 to 6 are termed narrow rations; those with ratios of 1 : 6 to 1 : 10, wide rations.

2. SOME GOOD FODDER RATIONS FOR FARM ANIMALS.

I. MILCH COWS AND GROWING NEAT STOCK.

These animals should have 16 pounds of digestible organic nutrients daily divided into: digestible protein, 2.50 to 3.00 pounds; digestible fat, .50 to 1.00 pounds; digestible carbohydrates, 12 to 13 pounds; on the basis of 1,000 pounds live weight. These various ingredients will be found in the correct proportions in the following combinations: —

I. Basal Rations.

(*a*)	(*b*)	(*c*)
English hay,* 18 pounds. Roots, . . 15 pounds.	English hay, 21 pounds.	English hay, . 4 pounds. Corn stover, . 4 pounds. Corn ensilage, 40 pounds.
(*d*)	(*e*)	(*f*)
Hay, . . 5 pounds. Dry corn fodder, 25 pounds.	Hay of vetch and oats, 10 pounds. English hay, 5 pounds. Corn stover, 6 pounds.	Green crops,† 50–70 pounds.

These coarse fodders for practical purposes can generally be fed *ad libitum; i. e.*, the animals can be given all they will consume. There are, of course, some exceptions, but the practised eye of the feeder will control such cases.

II. Grain Rations.

The following grain rations are combined to go with the above coarse fodders. These should always be weighed or measured out: —

---

* The many experiments at this station have shown that hay is too costly to be fed in large quantities to cows and growing stock. Its place should be taken by other coarse fodders.

† In case green leguminous crops are fed, only one-half to one-third of the grain ration that follows need be given.

(a)

Cotton-seed meal, . . .	100 pounds.
Wheat bran, ...	100 "
Corn meal,*	100 "

Mix and feed 9 quarts daily.

(b)

Chicago gluten meal, .	100 pounds.
Wheat bran, . . .	100 "
Gluten feed,* . . .	100 "

Mix and feed 9 quarts daily.

(c)

Linseed meal,† . . .	100 pounds.
Wheat bran, ...	100 "
Ground wheat, . . .	100 "

Mix and feed 9 quarts daily.

(d)

Linseed meal,†	100 pounds.
Pope or King gluten meal,	100 "
Wheat bran, ...	200 "

Mix and feed 9 quarts daily.

The maize or gluten feeds can be used interchangeably one for the other; the linseed meal and Chicago gluten meal can also be substituted one for the other. Cotton-seed meal, King gluten meal and Pope gluten meal should not be combined (especially in summer) with other concentrated foods rich in fat, and it is better to feed but one of these in any daily grain ration. To be on the safe side, we would not advocate more than 2 or at the utmost 3 quarts of these feeds daily.

In making up the grain rations, cost must be considered, and farmers will have to use judgment in this respect. Thus, if cotton-seed meal costs $24 per ton and Chicago gluten meal $26, the cotton-seed meal would be much more economical.

The following figures show the approximate *relative commercial values* of the grains, figured on the basis of the amount of digestible protein they contain. By this is meant that if corn meal was worth $21 per ton Chicago gluten meal would be worth $28, etc. This does *not* mean that these two grains, side by side, would have the same feeding effect, but the figures are presented as a basis to be used in purchasing: —

	Per Ton.
Corn meal, ...	$21 00
Wheat brans, ...	18 00
Gluten feeds,.	23 00
Gluten meals, ...	28 00
Cotton-seed meal,.	30 50
New-process linseed meal, ...	29 00
Old-process linseed meal, ...	28 25

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* Three quarts of either Buffalo gluten feed, Peoria gluten feed or Chicago maize feed can be substituted with good effect for the corn meal.

† Old or new process.

II. WINTER FODDER RATIONS FOR GROWING LAMBS (60 TO 100 POUNDS).

The following combinations of grains and coarse fodder have proved valuable as winter fodder rations for lambs (yearlings).

In general, where corn ensilage has been substituted for one-half to two-thirds of the rowen the growth has been fully as good and the cost of production of live weight somewhat less.

I.		II.	
Wheat bran,	0.50 lbs.	Wheat bran,	0.50 lbs.
Chicago gluten meal,	0.50 "	Chicago gluten meal,	0 50 "
Rowen,	2.00 "	Rowen,	1.00 "
Nutritive ratio,	1:4 50	Corn ensilage,	3.50 "
Total cost (approximate),	2.50 cts.	Nutritive ratio,	1:5 09
Manurial value obtainable,	1.15 "	Total cost (approximate),	2.24 cts.
Net cost,	1.36 "	Manurial value obtainable,	1.10 "
		Net cost,	1.14 "
III.		**IV.**	
Wheat bran,	0.50 lbs.	Wheat bran,	0.50 lbs.
Linseed meal,	0.25 "	Linseed meal,	0.25 "
Rowen,	1.50 "	Rowen,	0.50 "
Nutritive ratio,	1:4.0	Corn ensilage,	3.50 "
Total cost (approximate),	2.08 cts.	Nutritive ratio,	1:5.0
Manurial value obtainable,	1.02 "	Total cost (approximate),	1.8 cts.
Net cost,	1.06 "	Manurial value obtainable,	0.9 "
		Net cost,	0.9 "
V.		**VI.**	
Corn meal,	0.50 lbs.	Buffalo gluten feed,	0.75 lbs.
Cotton-seed meal,	0 50 "	Rowen,	2.00 lbs.
Rowen,	1.50 "	Nutritive ratio,	1:5.3
Nutritive ratio,	1:5.3	Total cost (approximate),	2.33 cts.
Total cost (approximate),	2 40 cts.	Manurial value obtainable,	1.25 "
Manurial value obtainable,	1.30 "	Net cost,	1.07 "
Net cost,	1.10 "		

VII.

Buffalo gluten feed,	0.75 lbs.
Cotton-seed meal,	0.25 "
Rowen,	0.50 "
Corn ensilage,	4.00 "
Nutritive ratio,	1:4.6
Total cost (approximate),	2.04 cts.
Manurial value obtainable,	1.14 "
Net cost	0.90 "

Linseed meal, cotton-seed meal and Chicago gluten meal can be substituted one for the other without very materially changing the cost of the ration or its feeding effect. Buffalo gluten feed and Chicago maize feed can also be used interchangeably.

One-half pound of rowen and four to five pounds of corn ensilage in a ration tend to cheapen the cost and are as effective in feeding value as one and one-half to two pounds of rowen. In general, four pounds of corn ensilage can be reckoned an equivalent for one pound of rowen, so far as dry matter is concerned.

The rations as given can be increased or decreased proportionately in quantity to suit the appetite and size of the animals fed.

III. Practical Rations for Pig Feeding.

When skim-milk is used as a part of the daily diet in feeding pigs for the market, the station feels justified, in view of its feeding experiments, in recommending the following practical rations as being valuable in producing pork at a minimum cost: —

I.

Weight of Pigs (Pounds).	Food.	Nutritive Ratio.
20 to 80,	2 ounces corn meal to each quart milk,*	1:3.30
80 to 125,	4 ounces corn meal to each quart milk,	1:4.00
125 to 190,	6 ounces corn meal to each quart milk,	1:4.50

* Creamery buttermilk can be substituted for skim-milk as above with good results if it can be had at a reasonable price, say 1.4 cents per gallon.

When skim-milk is in limited supply (from four to six quarts per pig), feed as follows: —

II.

Weight of Pigs (Pounds).	Food.	Nutritive Ratio.
20 to 80, .	Milk at disposal, and one part by weight wheat bran, two parts by weight gluten meal, to satisfy appetite.	1:3.20
80 to 125, .	Milk at disposal and following mixture: one weight part corn meal, one weight part wheat bran, one weight part gluten meal, to satisfy animal.	1:4.00
125 to 190, .	Milk at disposal and following mixture: two weight parts corn meal, one weight part wheat bran, one weight part gluten meal.	1:4.50

III.

Weight of Pigs (Pounds).	Food.	Nutritive Ratio.
20 to 80, .	2 ounces corn meal to each quart of milk and 4 ounces gluten feed as a substitute for each quart milk.	1:3.25 to 4.00
80 to 125, .	6 quarts skim-milk and a mixture of one part by weight gluten feed and one part by weight corn meal.	1:4.00 to 4.40
125 to 190, .	6 quarts skim-milk and a mixture of one part by weight gluten feed and one and one-half parts by weight corn meal.	1:4.4 to 4.9

IV. RATIONS FOR FARM HORSES.

While we have never carried out any direct experiments with horses, the following rations, fed to our farm horses, have given very excellent results (basis 1,000 pounds live weight): —

(a) *Light Work* (*Winter*).

	Pounds.
Hay,	15
Wheat bran,	2
Provender,	4

(b) *Medium Work.*

	Pounds.
Hay,	15
Wheat bran,	3
Provender,	6

(c) *Hard Work.*

	Pounds.
Hay,	15
Wheat bran,	4
Provender,	8

The provender consists of cracked corn and oats, in the proportion of 400 pounds of the former to 15 bushels of the latter.

The following table shows the pounds of digestible nutrients in our ration for medium work, as compared with Wolff's for horses of 1,000 pounds live weight, doing medium work and hard work: —

	Digestible Protein (Pounds).	Digestible Fat (Pounds).	Digestible Carbohydrates (Pounds).	Total Digestible Matter (Pounds).	Nutritive Ratio.
Medium work,	1.58	0.43	11.25	13.26	1:7.81
Wolff's standard, medium work,	1.55	0.55	10.85	12.95	1:7.80
Wolff's standard, hard work,	2.12	0.83	12.63	15.58	1:7.00

II.

OBJECTS OF THE FOLLOWING EXPERIMENTS.

III. Feeding Experiments with Milch Cows.

1. October to December, 1893.

To note the comparative feeding effects of English hay, hay of vetch and oats and soja bean and barley straw upon the production and cost of milk.

Grain feed was constant, and consisted of wheat bran, Buffalo gluten feed and new-process linseed meal.

2. January to May, 1894.

(*a*) To determine how much digestible protein can be economically fed to milch cows.

(*b*) To determine the effect of different quantities of protein upon the quantity and quality of the milk.

3. Creamery Record of the Station.

The tabulated results of the station herd for 1893 and 1894.

IV. Hay Substitutes.

A résumé of some experiments with vetch and oats and peas and oats, calling attention to their value for milk production, as compared with English hay.

V. The Babcock *v.* the Space System as a Basis for Payment in Massachusetts Creameries.

The object of this experiment is to call attention to the composition of cream from various patrons raised by the deep-setting process, in order to see if the payment for cream by the space (or fraction of an inch) is equally just to all parties. The Babcock method is contrasted with the space system.

VI. FEEDING EXPERIMENTS WITH STEERS.

(*a*) To note the effect of distinct fodder rations upon the production of live weight.

(*b*) To secure facts relative to the actual cost of beef production in Massachusetts under existing local conditions.

(*c*) To compare the relative merits and cost of pasture *v.* soiling during the summer season. (A résumé of all our experiments with steers follows this experiment.)

VII. FEEDING CALVES FOR VEAL.

(*a*) To see if it were possible to replace the butter fat removed in the cream by some cheaper fat or oil, thus producing a mixture resembling in composition whole milk.

(*b*) To see if such a mixture would fatten calves economically.

VIII. DIGESTION EXPERIMENTS WITH SHEEP.

1. To study the digestibility and consequent value as a source of food of a variety of concentrated cattle foods.

2. The digestibility of the pentosans. An investigation into the value as a source of food of a group of substances, called pentosans, found in most of our cattle foods, concerning which our knowledge heretofore has been very limited. This article at the present time has rather more of a scientific than practical interest.

III.

FEEDING EXPERIMENTS WITH MILCH COWS.

1. COMPARATIVE VALUE OF DIFFERENT COARSE FEEDS.

By J. B. Lindsey.

October–December, 1893.

[Grains fed: wheat bran, Buffalo gluten feed, new-process linseed meal. Coarse feeds: hay, dry vetch and oats, soja-bean hay and barley straw.]

Object of the Experiment.

To note the comparative effect of English hay, dry vetch and oats, soja-bean hay and barley straw upon the production and cost of milk.

Results of the Experiment.

The average cost of producing milk from six cows of the station herd in different periods of lactation was 2.3 cents per quart; the average yield was 9.46 quarts per day.

Hay of vetch and oats compared very favorably with English hay for milk production.

The composition of the milk was apparently not affected by the different coarse fodders.

The Experiment.

The analyses of the foods fed and their fertilizing value, the history and feeding record of the individual cows, etc., will be found at the end of the experiment.

Six cows were used in the trial; they were grades of various breeds in different periods of lactation, yielding from 7 to 15 quarts of milk daily.

The fodder articles were all in good condition, and may be considered fair samples of their kind.

During the entire feeding trial the grain ration remained constant, the coarse fodders alone being changed. The cows were fed, watered and milked twice daily, one-half the food being given at each feeding. They were allowed outdoor exercise on every pleasant day. They were weighed once a week, after the morning's feeding and milking but before being watered.

A composite sample of the milk was taken three days of each week during the trial, thus furnishing the average of every six milkings out of fourteen. This at least gives a good average for each week.

Average Composition of the Daily Fodder Rations (1893–94).

I.		II.	
October 5 to October 16.		*October 25 to November 27.*	
Wheat bran,	3.00 lbs.	Wheat bran,	3.00 lbs.
Buffalo gluten feed,	3.00 "	Buffalo gluten feed,	3.00 "
New-process linseed meal,	3.00 "	New-process linseed meal,	3.00 "
Hay,	17.63 "	Hay of vetch and oats,	16.52 "
Nutritive ratio,	1:4.40	Nutritive ratio,	1:4.20
Total cost,	22.97 cts.	Total cost,	22.14 cts.
Manurial value obtainable,	10.85 "	Manurial value obtainable,	11.28 "
Net cost,	12.12 "	Net cost,	10.86 "

III.	
December 9 to January 2.	
Wheat bran,	3.00 lbs.
Buffalo gluten feed,	3.00 "
New-process linseed meal,	3.00 "
Soja-bean hay,	10.81 "
Barley straw,	4.56 "
Nutritive ratio,	1:4.13
Total cost,	20.14 cts.
Manurial value obtainable,	10.79 "
Net cost,	9.35 "

Three pounds wheat bran equal 4 quarts; 3 pounds Buffalo gluten feed equal 3 quarts; 3 pounds new-process linseed meal equal 2¼ quarts.

The *total cost* of a fodder ration is the sum of the market costs of the different articles consumed per day. The *manurial value obtainable* is the value of the nitrogen, phosphoric acid and potash of the ration fed that will be found in the manure. In case of milch cows this amounts on an average to 80 per cent. of the fertilizing ingredients contained in the feed. The other 20 per cent. goes into the milk or flesh of the animal. The value of the nitrogen, phosphoric acid and potash thus excreted is based upon the retail cost of these articles in the open markets. When the experiment was in operation this amounted to 15 cents per pound for nitrogen, 5½ cents per pound for phosphoric acid and 4½ cents per pound for potash. The *net cost* of a ration is that cost remaining after the value of the manure has been deducted from the total cost.

Quantity and Cost of Milk produced Daily.

FEEDING PERIODS.	NETTIE.		JENNIE.		GEM.		JULIA.		NORA.		NELLIE.		AVERAGE.	
	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.
	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.
I., . .	14.40	1.61	6.82	3.19	8.87	2.62	8.64	2.69	8.82	2.64	13.77	1.67	10.22	2.25
II., . .	12.69	1.87	5.88	3.47	9.14	2.42	8.46	2.62	8.26	2.69	12.17	1.82	9.43	2.35
III., . .	11.24	1.81	5.11	3.72	8.85	2.36	7.53	2.80	8.10	2.44	11.54	1.71	8.73	2.31

If we notice the averages in the above table, it will be seen that the cows declined slightly and regularly in the yield of milk during the three months of trial. There was a decrease of 7.8 per cent. in the milk production between the first and second periods and a further decrease of 6.8 per cent. between the second and third periods, making a total decrease of 14.6 per cent. during the three months of trial. This is by no means excessive. Five of the six cows gave an average increase of 19 pounds each in live weight during the vetch and oats period. When it is also remembered in cases of the hay and the vetch and oats periods that the former lasted but 12 days and the latter 34 days, the difference in yield in favor of the hay would be still further reduced. The cost of feed per quart of milk is about the same in all three periods, a very slight difference in favor of the hay period being observed, which would probably be counterbalanced when the longer vetch and oats period and the natural decline in yield are considered. The vetch and oats hay compared, then, quite well with the first cut hay of upland meadows.

While the soja-bean hay and barley straw compared very favorably with the other coarse fodders, it is hardly to be commended, because of the tendency of the bean leaves of the soja-bean plant, like all leguminous crops, to dry up and fall off in the process of curing. The soja bean can be much better preserved in the silo mixed with corn fodder.

Quality of Milk Produced.

Feeding Periods.	Rations.	Nettie.		Jennie.		Gem.		Julia.		Nora.		Nellie.	
		Total Solids.	Fat.	Total Solids.	Fat.	Total Solids.	Fat.	Total Solids.	Fat.	Total Solids.	Fat.	Total Solids.	Fat.
I. 12 days.	Grain and hay, ...	12.17	3.62	15.11	5.81	13.38	4.76	14.94	5.75	13.54	4.60	15.78	6.60
	Grain and hay, ...	12.71	3.95	15.26	5.80	13.29	4.55	14.57	5.72	13.46	4.20	13.31	4.00
	Average, ...	**12.44**	**3.79**	**15.19**	**5.81**	**13.34**	**4.66**	**14.76**	**5.74**	**13.50**	**4.40**	**14.55**	**5.30**
II. 34 days.	Grain and hay of vetch and oats, ...	12.40	3.90	16.16	6.20	13.85	4.78	13.81	4.60	13.66	4.40	14.26	5.10
	Grain and hay of vetch and oats, ...	12.59	3.43	16.69	6.40	14.08	5.00	13.78	3.98	12.29	2.93	13.56	3.78
	Grain and hay of vetch and oats, ...	12.80	3.85	16.84	6.45	13.24	4.15	14.34	4.43	13.42	3.82	13.81	3.80
	Grain and hay of vetch and oats, ...	13.07	3.80	15.64	5.43	13.61	4.50	14.28	4.65	13.24	3.60	13.83	3.80
	Grain and hay of vetch and oats, ...	13.23	3.90	15.39	5.40	13.39	4.40	14.39	5.00	13.53	4.20	14.20	4.30
	Average, ...	**12.82**	**3.78**	**16.14**	**5.98**	**13.63**	**4.57**	**14.12**	**4.53**	**13.23**	**3.79**	**13.93**	**4.15**
III.* 25 days.	Grain, soja-bean hay and barley straw, ...	12.81	3.40	15.63	5.78	13.40	4.40	14.09	4.63	13.35	3.75	13.54	3.60
	Grain, soja-bean hay and barley straw, ...	12.58	3.60	16.07	6.30	13.43	4.50	14.46	5.00	13.54	4.00	14.15	4.25
	Grain, soja-bean hay and barley straw, ...	13.16	4.30	16.05	6.30	13.25	4.40	14.32	5.00	13.10	4.05	13.94	4.30
	Average, ...	**12.85**	**3.77**	**15.92**	**6.13**	**13.36**	**4.43**	**14.29**	**4.88**	**13.33**	**3.93**	**13.88**	**4.05**

* In the cases of Jennie and Julia the third period lasted only 20½ days.

In case of cows Nettie, Jennie and Gem the percentage of solids and fat remained very constant during the three periods, while the solids and fat of the milk of cows Julia, Nora and Nellie show a decrease in the last two periods. This decrease can only be explained on the ground that the change of feed interfered for a time with the process of secretion. Towards the end of each period it is noted that the composition of the milk of two of three cows approached that of the first period again. Cows Nora and Nellie seemed for quite a while to produce milk of a varying fat content.

DETAILS OF THE EXPERIMENT.

FEEDING RECORD.

Nettie.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.							Dry Matter consumed per Day (Pounds).	Milk produced per Day (Quarts).	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Wheat Bran.	Buffalo Gluten Feed.	New-process Linseed Meal.	Hay.	Hay of Vetch and Oats.	Soja-bean Hay.	Barley Straw.					
1893-94.												
Oct. 5 to Oct. 16, . .	3.00	3.00	3.00	18.00	-	-	-	23.36	14.40	1.62	1:4.45	882
Oct. 25 to Nov. 27, . .	3.00	3.00	3.00	-	18.71	-	-	23.65	12.69	1.86	1:4.40	917
Dec. 9 to Jan. 2, . .	3.00	3.00	3.00	-	-	11.24	4.41	21.32	11.24	1.90	1:4.10	907
Jennie.												
Oct. 5 to Oct. 16, . .	3.00	3.00	3.00	16.00	-	-	-	21.66	6.82	3.18	1:4.20	806
Oct. 25 to Nov. 27, . .	3.00	3.00	3.00	-	14.21	-	-	19.90	5.88	3.38	1:4.10	818
Dec. 9 to Dec. 29,* . .	2.78	2.78	2.78	-	-	9.43	4.29	19.70	5.11	3.86	1:4.00	831

						Gem.						
Oct. 5 to Oct. 16, . .	3.00	3.00	3.00	18.00	-	-	-	23.36	8.87	2.63	1:4.45	1,070
Oct. 25 to Nov. 27, . .	3.00	3.00	3.00	-	16.53	-	-	21.83	9.14	2.39	1:4.20	1,087
Dec. 9 to Jan. 2, . .	3.00	3.00	3.00	-	-	11.82	4.61	22.00	8.85	2.49	1:4.20	1,080
						Julia.						
Oct. 5 to Oct. 16, . .	3.00	3.00	3.00	18.00	-	-	-	23.36	8.64	2.70	1:4.45	873
Oct. 25 to Nov. 27, . .	3.00	3.00	3.00	-	16.51	-	-	21.82	8.46	2.58	1:4.20	891
Dec. 9 to Dec. 29,* . .	3.00	3.00	3.00	-	-	11.97	4.66	22.15	7.53	2.94	1:4.20	899
						Nora.						
Oct. 5 to Oct. 16, . .	3.00	3.00	3.00	18.00	-	-	-	23.36	8.82	2.65	1:4.45	809
Oct. 25 to Nov. 27, . .	3.00	3.00	3.00	-	16.60	-	-	21.89	8.26	2.65	1:4.20	821
Dec. 9 to Jan. 2, . .	3.00	3.00	3.00	-	-	10.19	4.68	20.68	8.10	2.55	1:4.00	832
						Nellie.						
Oct. 5 to Oct. 16, . .	3.00	3.00	3.00	17.75	-	-	-	23.15	13.77	1.68	1:4.40	902
Oct. 25 to Nov. 27, . .	3.00	3.00	3.00	-	16.56	-	-	21.86	12.17	1.80	1:4.20	882
Dec. 9 to Jan. 2, . .	3.00	3.00	3.00	-	-	10.20	4.68	20.69	11.54	1.79	1:4.00	851

* Sold.

History of Cows.

NAME OF COW.	BREED.	Age (Years).	LAST CALF DROPPED.	Daily Yield of Milk at Beginning of Trial (Quarts).
Nettie, . .	Grade Holstein, .	5	July 2, 1893,	15
Jennie, . .	Grade Jersey, .	4	Dec. 25, 1892,	7
Gem, . .	Grade Shorthorn, .	6	Dec. 6, 1891,	8–9
Julia, . .	Native, . . .	9	Jan 18, 1893,	9-10
Nora, . .	Grade Ayrshire, .	5	Mar. 25, 1893,	10
Nellie, . .	Native, . . .	8	Aug. 15, 1893,	14

Local Market Cost, per Ton, of the Various Articles of Fodder Fed.

Wheat bran, ...	$19 00
Buffalo gluten feed, ...	19 00
New-process linseed meal, ...	27 00
Hay, ...	15 00
Hay of vetch and oats, ...	15 00
Soja-bean hay, ...	15 00
Barley straw, ...	10 00

Analyses of Fodder Articles.

FODDER ANALYSES.	Wheat Bran.	Buffalo Gluten Feed.	New-process Linseed Meal.	Hay.	Hay of Vetch and Oats.	Soja-bean Hay.	Barley Straw.
Moisture at 100° C., . .	12.42	8.30	10.62	15.00	16.67	16.21	12.80
Dry matter, ...	87.58	91.70	89.38	85.00	83.33	83.79	87.20
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.							
Crude ash, ...	6.10	0.91	5.89	7.83	11.38	12.62	4.94
" cellulose, . . .	11.06	7.96	8.84	32.74	30.15	27.73	39.84
" fat, ...	6.10	14.25	3.94	3.08	3.45	2.55	2.49
" protein, . . .	18.29	22.48	40.79	10.79	13.51	14.89	6.21
Nitrogen-free extract, . .	58.45	54.40	40.54	45.56	41.51	42.21	46.52
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Digestion Coefficients.

	Wheat Bran.	Buffalo Gluten Feed.	New-process Linseed Meal.	Hay.	Hay of Vetch and Oats.	Soja-bean Hay.	Barley Straw.
Crude cellulose, ...	25	43	61	60	66	58	56
" fat, ...	72	81	91	49	19	14	42
" protein, ...	78	85	87	60	60	64	20
Nitrogen-free extract, . .	68	81	86	60	54	61	54

Fertilizing Constituents.

[Nitrogen 17½ cents, phosphoric acid 5 cents, potassium oxide 5½ cents, per pound.]

	Wheat Bran.	Buffalo Gluten Feed.	New-process Linseed Meal.	Hay.	Hay of Vetch and Oats.	Soja-bean Hay.	Barley Straw.
Moisture, ...	12.42	7.32	10.89	15.00	16.67	16.21	12.80
Nitrogen, ...	2.56	3.33	5.83	1.47	1.81	2.00	0.86
Phosphoric acid, ...	2.46	0.37	1.95	0.27	0.50	0.50	0.12
Potassium oxide, ...	1.60	0.11	1.08	1.50	1.24	1.24	2.60
Valuation per 2,000 pounds,	$13 18	$12 15	$23 55	$7 07	$8 20	$8 86	$5 99
Manurial value obtainable, .	10 54	9 72	18 84	5 66	6 56	7 09	4 79

2. EFFECT OF FOOD UPON THE COST AND QUALITY OF MILK.

By J. B. Lindsey.

January–May, 1894.

Objects of the Experiment.

I. To determine how much digestible protein can be economically fed to milch cows.

II. To determine the effect of different quantities of protein upon the quantity and quality of the milk.

Brief Explanation of the Objects Sought.

By digestible protein is meant the nitrogenous part of the food consumed and digested. The non-nitrogenous part, *i.e.*, that which is not protein, is the cellulose, starch, sugars, gums and fatty substances.

Very much is being said at the present time by our experiment stations and intelligent dairy farmers about the value of different rations for the dairy cow. What is the most suitable nutritive ratio * of these fodder rations, or how much protein shall be fed in the ration, is a question of economical importance, for the protein is the most costly of all the fodder constituents.

Again, the writer deems it advisable, partly as an object lesson and partly for more light on the subject, — recognizing at the same time the work already accomplished, — to note the effects of different amounts of protein upon the composition or quality of the milk.

General Teachings of the Experiment.

1. The amount of protein fed in the various fodder rations varied from 1.3 to 3.76 pounds daily to cows averaging 871 pounds live weight. The ration containing the most protein produced milk at a less cost per quart in each

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* By nutritive ratio is meant the proportion which the nitrogenous bears to the non-nitrogenous part of the food.

of the three series of experiments, besides furnishing a better quality of manure.

2. During the autumn, winter and spring months from 2.5 to 3 pounds of protein can be fed daily to dairy cows in good condition (on a basis of 1,000 pounds live weight) with economy and consequent profit. During the summer months it might not be advisable to feed over 2.5 pounds of digestible protein in the fodder ration in case of stall-fed cows, and one should be especially careful at that season about feeding grains containing an excess of fat (see caution elsewhere).

3. When as low as 1.3 pounds of protein were fed daily, the total digestible organic matter at the same time being sufficient for the animal's daily needs, the quality of the milk, especially its fat content, was below that produced by a ration containing 2.5 to 3 pounds of digestible protein.

4. When 3 pounds of protein were fed in the daily ration there was an indication that its influence upon the quality of the milk ceased to be felt.*

5. All of the cows were not affected alike by the same fodder ration.

6. The total solid matter in the milk was much less affected than the fat.

7. This experiment points out the economy of feeding properly balanced rations in order to secure maximum and long-continued milk yields, as well as the best quality of manure.

GENERAL INTRODUCTION.

The German investigator, E. von Wolff,† who has closely studied the results of all German investigators concerning the most suitable fodder rations for milch cows, has given the following standard ration on a basis of 1,000 pounds live weight: —

Digestible protein, ...	2.50 lbs.
Digestible fat, ...	0.60 "
Digestible carbohydrates, ...	13.00 "
Nutritive ratio, ...	1:5.4

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* It is hoped that it will be possible to still further study this question of the effect of food and especially protein upon the quality and quantity of the milk produced.

† Die Ernährung der Landwirthschaftliche Nützthiere, 1876, p. 548.

He claims that about 2.5 pounds of digestible protein should be contained in the ration fed in order to keep the animal in good condition and to keep up the quantity of milk for the longest possible time.

Märcker and Morgen,* as a result of their experiments with five different herds of cows, claim that more protein than the current usage and feeding standards call for can be economically fed, thus: —

	I.	II.
Digestible protein (pounds),	4.06	3.42
Digestible fat (pounds),	0.60	0.50
Digestible carbohydrates (pounds),	13.80	13.84
Nutritive ratio,	1:3.8	1:4.4

While this might be economically true in sections of Germany, it does not necessarily hold that it is economically true in Massachusetts.

Woll † has made quite a thorough inquiry into the rations fed by successful dairymen in different sections of the United States, and calls the average of his results the American standard ration, which he believes to be correct for the larger part of the United States. It is as follows: —

Digestible protein,	2.15 lbs.
Digestible fat,	0.74 "
Digestible carbohydrates,	13.27 "
Nutritive ratio,	1:6.9

He furnishes no results of experiments to prove this to be the case, simply basing his conclusion upon the opinion of dairy farmers. Whether the judgment of dairy farmers is correct or not we will not at this point express an opinion, but it seems to the writer a rather peculiar position for a scientific inquirer to take.

During the winters of 1892–93 and 1893–94 Messrs. Woods and Phelps ‡ made investigations concerning the fodder rations fed by many prominent dairymen in Connecticut, and found them containing about 2.5 pounds of digestible protein and 17.5 pounds of total digestible nutrients. Where rations poorer in protein were fed than the above, the milk produced was noted, then a change in the ration was suggested, and later the production of the herd was again accurately observed.

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* Résumé in Experiment Station Record, March, 1892.

† Bulletin No. 38, Wisconsin Experiment Station.

‡ Bulletin No. 13, Storr's Experiment Station.

They recommended, as a "tentative ration," 2.5 pounds of digestible protein and 16 pounds of total digestible organic matter, — practically the German standard.

The many experiments already carried out at the Massachusetts station have shown the economy of feeding at least 2.5 pounds of digestible protein in the daily ration.

There appears, however, to be a difference in opinion as to the amount of protein that can be *economically fed* to our dairy cows, and the investigation that follows is a step towards the solution of the problem.

In the second place, we have endeavored to note if the varying amounts of protein in rations that contain sufficient total digestible organic nutrients have had any noticeable effect upon the *quality* of the milk produced.

E. Wolff* and G. Kühn† during the years 1868–76 made this subject a special study. The results of their investigation may be stated concisely as follows: —

That milk production is dependent, in the first place, upon the individuality of the cow and upon the development of the milk glands. It is impossible to radically change the composition of the milk by means of food, to transform a "butter cow" into a "cheese cow" at will, etc. On the other hand, there are cows whose milk can be influenced by the foods fed, but only to a limited degree. In the thirty cows that were accurately studied there were only two where such an influence of the fodder was decidedly proved. With some of the other cows very slight changes only were noticed. Of all the milk components, the fat was by far the most influenced by the food supply.

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* E. Wolff, "Die Verssuchsstation Hohenheim," Berlin, 1870.

† Journal für Landw , 1874; Landw. Verssuchsstation, 1869; Résumé in Die Ernährung der Landwirthschaftliche Nützthiere, E. Wolff, 1876.

The one-sided increase in the milk fat in case of individual cows was parallel with the increased supply of digestible protein. Different concentrated feeds appeared also to have increased the percentage of fat.* A previously well-fed cow, fed so as to be poorly nourished,† would decrease in her flow, and the quality of the milk would be, as a rule, gradually impaired, though not radically affected. Upon these experiments of Wolff and Kühn is based our present knowledge of the subject under consideration.

In 1891 W. Fleischmann‡ presented the results of his studies upon a large herd of cows. He did not study this especial point, namely, the effect of increasing amounts of protein on the quality of the milk; but he makes, in connection with his conclusions, the following interesting observation: "The fact long believed to be true in practice, namely, the increasing the amount of food nutrients to make the milk of cows richer in fat absolutely as well as relatively, would seem to be fully confirmed."

Kochs and Ramm§ studied this subject in 1891, using three cows of different breeds, and concluded that in case of their experiment the food had no effect upon the fat content of the milk.

From 2.2 to 4.4 pounds of digestible true protein were fed daily, and approximately 21 to 23 pounds of total digestible organic matter, on the basis of 1,000 pounds live weight. The weakness of this experiment is at least twofold: first, because of the few cows used; and second, because each cow was not fed with the exact ration belonging to her, but the entire food weighed out for the three cows was given to them collectively.

It will be noticed that the smallest amount of protein was 2.25 pounds. The amount of total digestible organic matter fed was, however, above Wolff's standard, so that the nutritive ratio was 1 : 8.00.

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* Palmnut meal and bean meal.

† I wish to state that a milch cow can be poorly nourished in two ways: first, by not getting sufficient food to eat; and second, while she may get enough to eat, the food for milk production might be what is termed an improperly balanced one. Hay, for example, contains a large excess of carbohydrates and not enough protein.

‡ Landw., Jahrb., 20, 1891, Supplement II; Résumé in Experiment Station Record, Vol. III, p. 424.

§ Landw., Jahrb., Bd. xxi, 1892, p. 809.

W. H. Jordan* gives the results of several trials. In the first experiment three cows were used. The animals were fed in the second period of 14 days on hay and corn meal, and in the first and third periods 2 pounds of cotton-seed meal were substituted for 2 pounds of corn meal. Otherwise the food was alike in all three periods. The corn meal ration contained .87 pound of digestible protein and 12.45 pounds total digestible organic nutrients for cows weighing 925 to 950 pounds, — clearly an insufficient amount, as the experimenter states. The cotton-seed ration contained 1.47 pounds of digestible protein and 12.41 pounds of total digestible organic nutrients, also insufficient in quantity, but still somewhat improved. Two of three cows showed a slight increase in the solid matter of the milk on the cotton-seed ration, and one a decrease. The percentage of fat in the milk of the same two cows, on a basis of 13 per cent. total solid matter, was quite uniform for all three periods. The milk of the cow that showed a decrease in per cent. of solid matter on the cotton-seed ration showed at the same time a slight decrease in the fat percentage, on the basis of 13 per cent. total solids.

We have here another example of how different cows are differently affected by similar foods. This experiment was repeated the next year with four cows, but as far as the components of the milk were concerned very little change was noted.

In 1893 the same investigator published the results of experiments with three cows. The total digestible nutrients fed were sufficient, and each period lasted 35 days. The milk was analyzed the last five days of each period.

The writer thinks it would have been better to have had the results of the composition of the milk for five days of each week for every period.

Only the very briefest résumé is here given: —

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* Maine Experiment Station, reports for 1885-86, 1886-87, 1893.

	Protein. Pounds fed.	Total Solids in Milk of Cows.			
		Cow A.	Cow B.	Cow L. S.	Average, Three Cows.
		Per cent.	Per cent.	Per cent.	Per cent.
Wide ration, ...	1.18	13.39	13.64	13.50	13.51
Narrow ration, . . .	2.09	14.11	13.92	14.27	14.10
Percentage increase of narrow over wide ration, . .	–	–	–	–	4.37

Per Cent. of Fat in Milk on a Basis of Fourteen Per Cent. Solids.

Wide ration, ...	1.18	4.43	4.45	4.43	4.43
Narrow ration, . . .	2.09	4.68	4.77	4.72	4.73
Percentage increase of narrow over wide ration, . .	–	**5.64**	**7.19**	**6.54**	**6.50**

This experiment would indicate that the increase of protein in the food had somewhat increased the per cent. of fat in the milk.

The experimenter draws the following conclusion: "In general, the milk was richer while the cows were fed the ration rich in protein, though with one cow it showed the largest per cent. of solids during the third period, while she was eating the corn-meal ration.

"In general, the proportion of fat increased throughout the experiment, without regard to what the cows were fed, and no evidence is furnished in support of the notion that by changing the food it is possible to produce more butter fat without an accompanying increased production of other milk solids."

Armsby * carried out similar experiments with three cows during the years 1885 and 1886. The digestible protein fed during 1885 was from 1.5 to 2 pounds daily and the total digestible organic nutrients 13.5 pounds daily to cows of about 850 pounds live weight. These rations were sufficient in quantity. During 1886 1.1 to 1.8 pounds digestible protein and 12.7 pounds of total organic nutrients were fed. The weight of the animals is not given, but probably they were about the same as in the previous experiment. Armsby failed to find any change in the composition of the milk that could be traced to food influence.

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* Wisconsin Experiment Station, reports for 1885 and 1886.

The New Hampshire Experiment Station* failed to note any decided improvement in the quality of the milk when rations containing sufficient digestible organic nutrients were fed, by varying the digestible protein from 2 to 3 pounds daily.

The Iowa Experiment Station in 1891 published the results of an experiment made "to determine the effect of food upon the quality of milk," without apparently endeavoring to note the effect of any particular group of constituents in the fodder ration. They compared the effect of corn meal (low in protein) with gluten meal (high in protein). They really fed one ration containing but 1.05 pounds of digestible protein and another containing 2.18 pounds. Four cows, averaging 1,000 pounds in live weight, were used in the experiment, — three grade Shorthorn and one grade Holstein. It is impossible, for lack of data, to calculate accurately the amount of digestible nutrients fed, but an attempt has been made below to get an approximate idea. It appears that neither the corn fodder nor the clover hay was tested for moisture or subjected to analysis.

Ration I.		Ration II.	
	Pounds.		Pounds.
Corn and cob meal, . .	12½	Sugar (gluten) meal, .	10
Corn fodder, . . .	12	Corn fodder, . . .	12
Clover hay, . . .	4	Clover hay, . . .	4

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* Bulletins 9 and 10.

	Ration I.	Ration II.	Per Cent. Increase of II. over I.
Digestible protein (pounds), ...	1.05	2.18	-
Total nutrients fed (pounds),. . . .	14.09	13.51	-
Nutritive ratio, ...	1:13.10	1:5.71	-
Total yield of milk (pounds),. . . .	3,302.50	3,399.50	2.94
Total solids (pounds), ...	392.08	428.21	9.21
Fat (pounds), ...	111.25	134.39	20.80
Per cent. of solids in milk, . . .	11.93	12.63	5.87
Per cent. of fat in milk, ...	3.37	3.94	16.90
Milk on basis of 12 per cent. total solids (pounds).	3,283.20	3,578.00	8.97
Fat, per cent., basis 12 per cent. solids, .	3.39	3.74	10.32

So far as one is able to judge from the data presented, these rations, other things being equal, were not sufficient for cows of 1,000 pounds live weight that had had calves but a short time previous to the experiment, and yielding 12 to 15 quarts of milk daily. They should apparently have received at least 3 pounds more of total digestible organic matter daily. This insufficient food would of itself have had a tendency to produce a poor quality of milk. In the corn and cob meal ration the protein supply was quite low, and it is surprising that the animals did not shrink more than 9 per cent. in their yield of milk on the basis of 12 per cent. solids below the sugar-meal ration. The milk of Ration I. shows the effect not only of lack of protein but of lack of sufficient food as well. In the sugar-meal ration the replacing of a pound of carbohydrates by a pound of protein is seen in the increase of the solid matter, and especially of the amount of fat. The weight of the animals at the beginning and end of the periods (21 days) is not given, but it is stated that "the variations were not greater than usually appear in the live weight of such animals, and did not surely indicate gain or loss."

It hardly seems possible to the writer that animals fresh in milk, with an average weight of 1,000 pounds, could be fed on such a food combination as Ration I. and not show the effect of it in a very short time. The data given show that the quantity of the milk was increased and the quality improved, especially its fat content, by increasing the supply of protein in the daily ration. The poor quality of the milk in Ration I. was due in all probability partly to the lack of food and partly to the small amount of protein present. The experiment teaches nothing new, as the investigators seem to think. It has long been recognized that when insufficient rations are fed, and they are at the same time especially lacking in protein, the milk of many cows will show a decrease in quality. The fat has a tendency to be more affected than the other ingredients.

The experiment made at the Massachusetts State Experiment Station about to be described in the following pages is intended first as an object lesson to our dairymen, and secondly it was made with a view of obtaining additional information of an economical as well as of a scientific nature upon this still somewhat disputed question.

PLAN OF THE EXPERIMENT.

The experiment was divided into three periods, known as Series I., II. and III. The preliminary feeding generally lasted seven days, and the period itself fourteen. In Series I. it required longer than seven days to get the cows accustomed to the ensilage. In Series III. *a* and *b*, the periods themselves lasted but nine days.

The distinct rations fed will be stated further on. In Series I. *a*, 2.58 pounds of protein (N.R. 1 : 4.8) were fed, and in Series I. *b*, 1.31 pounds of protein (N.R. 1 : 10). The ration *b* represents the way a great many New England farmers feed, while ration *a* is not far from the German standard. In Series II. *a*, 2.55 pounds of protein were fed, essentially the same as in Series I. *a;* and in Series II. *b*, 2.24 pounds of protein (N.R. 1 : 5.8) were fed, rather less in amount, and furnishing, consequently, a somewhat wider nutritive ratio. In this period also we get a direct comparison of the relative effect of Buffalo gluten feed and corn meal. In Series III. *a*, 2.91 pounds of protein (N.R. 1 : 4.4) were fed, and in Series III. *b*, 3.76 pounds of protein were fed, being relatively large amounts of protein with correspondingly narrow rations.

Strictly speaking, these series, so far as the yield of milk is concerned, can be compared only with themselves, but not with each other, for Series I. *a* and *b* was in operation during the latter part of January and the first half of February, Series II. *a* and *b* was completed about the end of March, and Series III. *a* and *b* about May 1. During this time the cows would naturally shrink some in their milk yield. In order to overcome so far as possible the natural milk shrinkage in comparing the effect of the rations in the three series on the total yield from the herd, the following plan was adopted: take, for example, Series I. *a* and *b*. Cows 1, 2 and 3 were fed the narrow ration, Series I. *a*, during the two weeks that cows 4, 5 and 6 received the wide ration, Series I. *b*; and then the operation was reversed, cows 1, 2 and 3 receiving the wide ration, Series I. *b*, while cows 4, 5 and 6 received the narrow ration, Series I. *a*. This plan was continued through the entire series.

History of Cows.

NAME OF COW.	BREED.	Age (Years).	LAST CALF DROPPED.	Daily Yield of Milk at Beginning of Trial (Quarts).
Nettie,	Grade Holstein,	8	July, 1893,	11
Mary,	Grade Durham,	8	Dec. 17, 1894,	12
Gem,	Grade Shorthorn,	6	Dec. 6, 1891,	9
Sarah,	Grade Jersey,.	6	Dec., 1893,	8½
Nora,	Grade Ayrshire,	6	Mar. 25, 1893,	7
Nellie,	Native,	9	Aug. 15, 1893,	10½
Hattie,	Grade Jersey,	6	Mar. 23, 1894,	13

The cows were six in number; during the last period Hattie was substituted for Sarah.

What the Cows were Fed.

In Series I. and II. the coarse fodder consisted of 3 to 4 pounds of dry corn stover and corn ensilage *ad libitum.* The corn ensilage was made from Pride of the North corn, and was cut and put in the silo when the kernels were glazing. It was of good quality. In Series III. the coarse fodder consisted of corn stover and a good quality of rowen.

The grains consisted of wheat bran, corn meal, Buffalo gluten feed, cotton-seed meal and Chicago gluten meal, all of good quality. One ounce of salt was fed daily. Its beneficial effect upon the appetite and circulation is generally acknowledged.

How the Cows were Fed and Kept.

The food was given in two portions, one-half about six o'clock in the morning and the other about four o'clock in the afternoon. The grains were fed dry. The cows were watered twice daily, after eating in the morning and before eating in the afternoon. The animals were well carded and allowed several hours' exercise in the yard whenever weather permitted. The animals were weighed weekly, in the morning before being watered.

Sampling the Milk.

A composite sample of the milk was made for three days of each week (six milkings), and this was taken to represent the average composition of the milk for the week.

*Average Composition of the Daily Fodder Rations (1894).**

Series I.†

a.		*b.*	
Wheat bran,	3.00 lbs.	Wheat bran,	4.50 lbs.
Buffalo gluten feed,	3.00 "	Corn meal,	4.50 "
Cotton-seed meal,	3 00 "	Corn stover,	4 00 "
Corn stover,	4.00 "	Corn ensilage,	43.50 "
Corn ensilage,	42.78 "	Nutritive ratio,	1:10
Nutritive ratio,	1:4.80	Total cost,	14.99 cts.
Total cost,	15.95 cts.	Manurial value obtainable,	5.84 "
Manurial value obtainable,	8.46 "	Net cost,	9.15 "
Net cost,	7.46 "		

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* See digestible nutrients fed to each cow, further on.

† Periods 14 days long.

Average Composition of the Daily Fodder Rations — Concluded.

SERIES II.*

a.		*b.*	
Wheat bran,	3.00 lbs.	Wheat bran,	3.00 lbs.
Buffalo gluten feed,	3.00 "	Cotton-seed meal,	3.00 "
Cotton-seed meal,	3.00 "	Corn meal,	3.00 "
Corn stover,	4.00 "	Corn stover,	4.00 "
Corn ensilage,	42.97 "	Corn ensilage,	46.41 "
Nutritive ratio,	1:4.8	Nutritive ratio,	1:5 8
Total cost,	15.97. cts.	Total cost,	16.40 cts.
Manurial value obtainable,	8 47 "	Manurial value obtainable,	8.00 "
Net cost,	7.50 "	Net cost,	8.40 "

SERIES III.†

a.		*b.*	
Wheat bran,	3.00 lbs.	Buffalo gluten feed,	3.00 lbs.
Cotton-seed meal,	3.00 "	Chicago gluten meal,	3.00 "
Corn meal,	3.00 "	Cotton-seed meal,	3.00 "
Rowen,	9.00 "	Rowen,	14.00 "
Corn stover,	6.56 "	Corn stover,	4.00 "
Nutritive ratio,	1:4.14	Nutritive ratio,	1:3.06
Total cost,	19 38 cts.	Total cost,	20.13 cts.
Manurial value obtainable,	10.12 "	Manurial value obtainable,	11.13 "
Net cost,	9.26 "	Net cost,	9.00 "

* Periods 14 days long. † Periods 9 days long.

Dates of the Series.

	SERIES I. *a.*	SERIES I. *b.*
Jan. 16 to Jan. 29,	Cows 1, 2 and 3.	Cows 4, 5 and 6.
Feb. 6 to Feb. 19,	Cows 4, 5 and 6.	Cows 1, 2 and 3.

	SERIES II. *a.*	SERIES II. *b.*
Feb. 27 to March 12,	Cows 1, 2 and 3.	Cows 4, 5 and 6.
March 19 to April 1,	Cows 4, 5 and 6.	Cows 1, 2 and 3.

	SERIES III. *a.*	SERIES III. *b.*
April 8 to April 16,	Cows 1, 2 and 3.	Cows 4, 5 and 6.
April 22 to April 30,	Cows 4, 5 and 6.	Cows 1, 2 and 3.

TABLE I.

(*a*) *Result of the Inquiry as to the Amount of Protein that can be Economically fed to Milch Cows daily.*

Quantity and Cost of Milk produced per Day.

FEEDING PERIODS.	NETTIE.		MARY.		GEM.		SARAH.		NORA.		NELLIE.	
	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.
	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.
Series I. *a*,	11.54	1.42	11.16	1.39	9.48	1.67	8.75	1.71	7.81	2.08	10.81	1.51
Series I. *b*,	9.65	1.55	9.75	1.65	8.40	1.78	8.32	1.66	7.26	2.08	10.65	1.41
Series II. *a*,	10.61	1.53	10.21	1.70	9.32	1.69	7.21	2.01	7.04	2.20	9.32	1.66
Series II. *b*,	9.45	1.73	8.26	2.12	8.54	1.02	7.94	1.95	7.29	2.30	10.32	1.60
Series III. *a*,	8.37	2.18	6.87	2.65	7.47	2.41	*13.75	1.50	7.24	2.85	8.92	2.31
Series III. *b*,	10.36	2.07	8.94	2.52	9.22	2.32	13.28	1.40	7.34	2.55	9.17	2.05

* Hattie, new cow.

TABLE II.

Summary for the Six Cows.

FEEDING PERIODS.	Pounds Protein fed Daily.	Average Weight.	Total Yield of Milk.	Total Cost per Quart.	Net Cost per Quart.	Total Amount of Butter Fat.	Total Cost per Pound.
		Pounds.	Quarts.	Cents.	Cents.	Pounds.	Cents.
Series I. *a*,* .	2.60	878	837.56	1.60	0.77	82.17	16.30
Series I. *b*,* .	1.30	867	756.51	1.66	1.02	67.37	18.67
Series II. *a*,* .	2.55	871	758.60	1.77	0.84	78.20	17.12
Series II. *b*,* .	2.24	873	725.04	1.90	0.97	70.09	19.66
Series III. *a*,† .	2.91	874	473.44	2.21	1.06	45.25	23.12
Series III. *b*,† .	3.76	862	524.94	2.11	0.93	50.95	21.69

* Period 14 days. † Period 9 days.

The above summary furnishes some very instructive lessons.

Series I. a and b.

Series I. *b* shows how a great many farmers feed. The ration contained some corn stover, with corn ensilage *ad libitum*, and 4.5 pounds each of wheat bran and corn meal.

This ration contains but 1.3 pounds of digestible protein. Series I. *a* shows a properly balanced ration, consisting of the same coarse fodders as *b* and three pounds each of wheat bran, Buffalo gluten feed and cotton-seed meal. The approximate total cost of *b* was 15 cents and the net cost 9.15 cents, while the total cost of ration *a* was 16 cents and the net cost 7.5 cents. While the total cost of ration *a* was a trifle more, the net cost was fully 1.5 cents less, due to the fact that this ration furnished a much better manure.

Ration *a* produced 837.5 quarts of milk, at a total cost of 1.6 cents per quart; and ration *b* produced 756.5 quarts of milk, at a total cost of 1.66 cents per quart. Note also that the net cost of a quart of milk in ration *a* was .72 cent and in ration *b* 1.02 cents. Thus not only were 81 quarts more of milk produced during the ration *a* period, but both the total and net cost of the milk were less.

Again, ration *a* produced 82.17 pounds of butter fat, and at a cost of 16.3 cents per pound; while ration *b* produced but 67.37 pounds, at a cost of 18.67 cents per pound. Whether or not the quality of the milk was affected by the different foods will be discussed further on.

The six cows fed on ration *b* showed an average decrease of eleven pounds in live weight. It is certain, however, that more flesh and fat were lost than the scales specified, for during Series I. *b* the animals looked thin and had every appearance of being improperly nourished. In all probability flesh and fat were replaced by water. It is very clear, then, that a ration containing 2.60 pounds of protein was more economical to feed than one containing approximately one-half that amount. This experiment deserves the serious attention of our farmers.

Series II. a and b.

This series can hardly be compared with Series I., as it was later and the animals had naturally shrunk some in their milk production. In ration *a* 2.55 pounds of protein were fed and in ration *b* 2.24 pounds, the only difference in the grain ration being that in ration *b* 3 pounds of corn meal took the place of 3 pounds of Buffalo gluten feed. The live weight of the animals remained constant during this series.

In ration *a* 35 quarts more of milk were produced, at .13 cent less per quart than in ration *b*. The net cost of the milk was correspondingly less. In ration *a* also 8 pounds more of butter fat were produced at 1.5 cents less per pound. These figures show the butter and milk producing power of the Buffalo gluten feed over the corn meal, or, more correctly speaking, the influence of even .25 pound more of digestible protein and also possibly the effect of the increased fat, in the daily fodder ration.

Series III. a and b.

The periods in this series lasted only nine days. In ration *a* 2.91 pounds of digestible protein were fed and in ration *b* 3.76 pounds. Here again we see the influence of the extra amount of protein in the fact that 51 quarts more of milk were produced during the nine-day period (equivalent to 78 quarts during 14 days), at .1 cent less per quart. The net cost of the milk in ration *a* was correspondingly less. In ration *a* 5.7 pounds more of butter fat were produced than in ration *b*, at 1.43 cents less per pound.

So far, then, as this one set of experiments is concerned, the largest amount of protein fed daily, viz., 3.76 pounds, was the most economical. It must be admitted that in feeding so much protein the animal is asked to do her best, and it is a question for how long a time she would be able to continue. The writer believes, however, that during the late fall and winter months cows that are in good condition can be fed from 2.5 to 3 pounds of digestible protein daily with profit. It probably would not be advisable to feed over 2.5 pounds daily to animals that are soiled during the spring, summer and early autumn.

Farmers are especially cautioned not to feed too large an amount of grain during the summer that contains a high percentage of fat. A large amount of fat in the daily ration at this season tends to overheat the animal and produce inflammation of the milk glands. Among such grains may be mentioned cotton-seed meal, Buffalo gluten feed, cream gluten meal, King gluten meal, etc. Not above 4 to 5 quarts of the Buffalo gluten feed or 2 quarts of any of the others should enter into any one daily grain ration during the summer months.

While 2.5 pounds or more of protein have been shown to be economical in the present experiment, the writer believes, with Wolff, that it is also *necessary to keep up the flow of milk for the longest possible time.* The demands upon the cow that produces 10 to 12 quarts of milk daily are severe, and she must be well supplied with sufficient digestible protein to meet these demands.

TABLE III.

(b) *Effect of Food (Protein) upon the Quality of the Milk.*

Quality of Milk Produced.

FEEDING PERIODS.	NETTIE.				MARY.				GEM.				SARAH.				NORA.				NELLIE.			
	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.
Series I. *a*, . .	12.97	4.05	8.92	1:2.20	14.14	5.00	9.14	1:1.83	13.23	4.60	8.63	1:1.88	13.83	4.40	9.43	1:2.14	13.84	4.20	9.64	1:2.30	14.13	4.50	9.63	1:2.14
Series I. *a*, . .	13.23	4.30	8.93	1:2.08	14.11	5.20	8.91	1:1.71	13.38	4.78	8.60	1:1.80	13.72	4.83	8.89	1:1.84	13.72	4.83	8.89	1:1.84	14.12	4.05	10.07	1:2.49
Average, .	13.10	4.18	8.92	1:2.13	14.13	5.10	9.03	1:1.77	13.31	4.69	8.62	1:1.84	13.78	4.62	9.16	1:1.98	13.78	4.52	9.26	1:2.05	14.13	4.28	9.85	1:2.30
Series I. *b*, . .	12.67	2.95	9.72	1:3.29	13.71	3.95	9.76	1:2.47	13.61	3.85	9.76	1:2.54	13.11	4.20	8.91	1:2.12	13.26	4.10	9.16	1:2.23	13.61	4.25	9.36	1:2.20
Series I. *b*, . .	13.33	4.00	9.33	1:2.33	14.18	4.85	9.33	1:1.92	13.12	4.20	8.92	1:2.12	13.41	4.48	8.93	1:1.99	13.59	4.55	9.04	1:1.99	14.11	4.50	9.61	1:2.14
Average, .	13.00	3.48	9.52	1:2.74	13.95	4.40	9.55	1:2.17	13.37	4.03	9.34	1:2.32	13.26	4.34	8.92	1:2.06	13.43	4.33	9.10	1:2.10	13.86	4.38	9.48	1:2.16
Series II. *a*, . .	13.73	4.60	9.13	1:1.98	14.29	5.20	9.09	1:1.75	13.65	4.80	8.85	1:1.84	13.47	5.20	8.27	1:1.59	13.72	4.90	8.82	1:1.80	13.75	4.40	9.35	1:2.13
Series II. *a*, . .	13.42	4.42	9.00	1:2.04	14.12	4.95	9.17	1:1.85	13.46	4.80	8.66	1:1.80	13.43	4.80	8.63	1:1.80	13.76	4.95	8.81	1:1.78	14.71	4.70	10.01	1:2.13
Average, .	13.58	4.51	9.07	1:2.01	14.21	5.08	9.13	1:1.80	13.56	4.80	8.76	1:1.83	13.45	5.00	8.45	1:1.69	13.74	4.93	8.81	1:1.79	14.23	4.55	9.68	1:2.13
Series II. *b*, . .	12.91	4.20	8.71	1:2.07	13.93	5.00	8.93	1:1.79	13.50	4.80	8.70	1:1.81	13.29	4.50	8.79	1:1.95	13.63	4.30	9.33	1:2.17	14.16	4.30	9.86	1:2.29
Series II. *b*, . .	13.50	4.30	9.20	1:2.14	14.65	5.30	9.35	1:1.76	13.57	4.60	8.97	1:1.95	12.62	4.20	8.42	1:2.00	13.46	4.40	9.06	1:2.06	14.27	4.20	10.07	1:2.40
Average, .	13.21	4.25	8.96	1:2.11	14.29	5.15	9.14	1:1.77	13.54	4.70	8.84	1:1.88	12.96	4.35	8.61	1:1.98	13.55	4.35	9.20	1:2.11	14.22	4.25	9.97	1:2.36
Series III. *a*, .	13.47	4.40	9.07	1:2.06	14.11	4.80	9.31	1:1.94	13.13	4.30	8.83	1:2.05	*13.26	4.60	8.66	1:1.88	13.76	4.20	9.56	1:2.28	14.69	4.30	10.39	1:2.42
Series III. *b*, .	13.31	4.05	9.26	1:2.29	14.00	5.00	9.00	1:1.80	13.07	4.20	8.87	1:2.11	13.90	4.75	9.15	1:1.93	13.61	4.30	9.31	1:2.17	14.76	4.70	10.06	1:2.14

* Hattie, new cow.

TABLE IV.

Summary of Averages.

	Digestible Protein Fed (Pounds).	NETTIE.				MARY.				GEM.			
		Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.
Series I. *a*,	2.60	13.10	4.18	8.92	1:2.13	14.12	5.10	9.03	1:1.77	13.31	4.69	8.62	1:1.84
Series I. *b*,	1.30	13.00	3.48	9.52	1:2.74	13.95	4.40	9.55	1:2.17	13.37	4.03	9.34	1:2.32
Per cent. increase *a* over *b*,	-	+0.77	+20.11	—6.30	-	+1.20	+1.60	—5.44	-	—0.45	+16.38	—7.71	-
Series II. *a*,	2.55	13.58	4.51	9.07	1:2.01	14.21	5.08	9.13	1:1.80	13.56	4.80	8.76	1:1.83
Series II. *b*,	2.24	13.21	4.25	8.96	1:2.11	14.29	5.15	9.14	1:1.77	13.54	4.70	8.84	1:1.88
Per cent. increase *a* over *b*,	-	+2.80	+6.12	+1.23	-	—0.56	—1.36	—0.11	-	+0.15	+2.08	—0.90	-
Series III. *a*,	2.91	13.47	4.40	9.07	1:2.06	14.11	4.80	9.31	1:1.94	13.13	4.30	8.83	1:2.05
Series III. *b*,	3.76	13.31	4.05	9.26	1:2.29	14.00	5.00	9.00	1:1.80	13.07	4.20	8.87	1:2.11
Per cent. increase *b* over *a*,	-	—1.19	—7.95	+2.09	-	—0.77	+4.17	—3.83	-	—0.45	—2.33	+0.45	-

TABLE IV. — *Concluded.*

Summary of Averages — Concluded.

	SARAH.				NORA.				NELLIE.			
	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.
Series I. *a*,	13.78	4.62	9.16	1:1.98	13.78	4.52	9.26	1:2.05	14.13	4.28	9.85	1:2.30
Series I. *b*,	13.26	4.34	8.92	1:2.06	13.43	4.33	9.10	1:2.10	13.86	4.38	9.48	1:2.16
Per cent. increase *a* over *b*,	+3.92	+6.45	+2.69	-	+2.61	+4.39	+1.76	-	+1.23	-2.29	+3.90	-
Series II. *a*,	13.45	5.00	8.45	1:1.69	13.74	4.93	8.81	1:1.79	14.23	4.55	9.68	1:2.13
Series II. *b*,	12.96	4.35	8.61	1:1.98	13.55	4.35	9.20	1:2.11	14.22	4.25	9.97	1:2.36
Per cent. increase *a* over *b*,	+3.77	+14.94	-1.89	-	+1.42	+11.76	-4.24	-	-0.07	+7.06	-2.91	-
Series III. *a*,	13.26	4.60	8.66	1:1.88	13.76	4.20	9.56	1:2.28	14.69	4.30	10.39	1:2.42
Series III. *b*,	13.90	4.75	9.15	1:1.93	13.61	4.30	9.31	1:2.17	14.76	4.70	10.06	1:2.14
Per cent. increase *b* over *a*,	+4.83	+3.26	+6.40	-	-1.09	+2.38	-2.61	-	+0.47	+9.30	-3.17	-

One cannot fail to note the variations in the composition of the milk obtained in the different series. The percentage increase or decrease in the per cent. of total solids is relatively small, being in most cases from 5 to 3 per cent. The percentage variations in the per cent. of fat, on the other hand, are much wider, in some cases as high as 16 per cent. or more being noted. With some of the cows, in cases where more protein was fed, the percentage of solids not fat shows a steady decrease, the fat, on the other hand, increasing even more, showing that the solids not fat were somewhat depressed at the expense of the fat. With other cows this variation in solids not fat was very slight.

Series I. a and b.

In Series I. *b*, when but 1.30 pounds of digestible protein were fed in the daily ration, the amount of fat in the milk is noticeably lower than in Series I. *a*, when double the amount of protein was consumed daily. The percentage increase in the per cent. of the fat in Series I. *a* is also high, varying from 4 to 20 in case of the first five cows.

The total solids were also increased in *a*, but to a much less degree.

The solids not fat showed a percentage of decrease in case of the first three cows of some 6 per cent., and with the last three a slight increase appeared. The ratio of fat to solids not fat should by no means pass unnoticed. In case of the first five cows, in *a* it was as 1 : 1.95, while in *b* as 1 : 2.36.

The cows also differed in what may be termed their susceptibility to the influence of the different fodder rations. The percentage of fat increase in the milk in case of cows Sarah and Nora was not so great as in case of the first three cows; while in case of Nellie the extreme food changes seemed to have had a comparatively small influence on the composition of the milk. The animal appeared, however, to feel more than any of the other cows the bad effect of the improperly combined ration *b*. Her whole general appearance told of a non-suitable food supply. This cow illustrates quite clearly the fact that the composition of the milk of different cows can be differently affected by the same food combinations. Although she gave every appearance of receiving improper nourishment, she still maintained the quality of her milk. It is to be noticed that the milk of the last three cows appeared to be less affected than that of the first three. This might in a measure at least be due to other than food influences, for the two lots of cows received the same rations at different dates. The temperature of the stable showed no wide variations during either *a* or *b*.

Series II. a and b.

Here the differences are not so marked. Nettie, Sarah, Nora and Nellie show, however, a higher percentage of fat in case of ration *a*, when more protein and fat were fed. The total solids of Nettie, Sarah and Nora are also higher, but the percentage increase is not nearly as marked as in case of the fat. The solids not fat on the whole appear to have been little affected. The ratio of fat to solids not fat for the six cows fed on ration *a* is as 1 : 1.88; while ration *b* was fed the ratio is as 1 : 2.03.

Series III. a and b.

The ratio of fat to solids not fat in *a* is as 1 : 2.10 and in *b* as 1 : 2.07, showing practically identical results. The variations in the per cents. of both the solids and the fat are in nearly every case quite small.

In order to get a better illustration of the effect of the food or protein upon the fat of the milk, the following table is presented, showing the fat percentage on the basis of 13 per cent. of solid matter in the milk: —

TABLE V.

Showing Fat Percentages on Basis of 13 Per Cent. Total Solids.

	Protein fed (Pounds).	Nettie. (Per Cent. Fat.)	Mary. (Per Cent. Fat.)	Gem. (Per Cent. Fat.)	Sarah. (Per Cent. Fat.)	Nora. (Per Cent. Fat.)	Nellie. (Per Cent. Fat.)
Series I. *a*, ...	2.60	4.15	4.69	4.58	4.36	4.27	3.93
Series I. *b*, ...	1.30	3.48	4.10	3.92	4.25	4.11	4.11
Percentage increase *a* over *b*, .	-	+13.51	+14.40	+16.84	+2.59	+3.89	—4.38
Series II. *a*, ...	2.55	4.32	4.65	4.60	4.83	4.66	4.16
Series II. *b*, ...	2.24	4.18	4.68	4.51	4.36	4.18	3.88
Percentage increase *a* over *b*, .	-	+3.35	±	+2.00	+10.78	+11.48	+7.22
Series III. *a*, ...	2.91	4.25	4.42	4.26	4.51	3.96	3.81
Series III. *b*, ...	3.76	3.98	4.64	4.18	4.44	4.11	4.14
Percentage increase *b* over *a*, .	-	—6.35	+4.97	—1.88	—1.55	+3.78	+8.66

The same remarks that were made in relation to the previous table apply with equal force here. In Series I. the fat percentage is distinctly higher in *a* than in *b*, the per cent. increase in percentage of fat in case of five cows being from 2.5 to nearly 17 per cent. In Series II. *a*, when 2.55 pounds of protein were fed, the per cent. increase in the percentage of fat is from 2 to 11.50 per cent. above that obtained in *b*, when 2.24 pounds of protein were consumed. In Series III. no distinctly noticeable effect of the food is to be seen on the percentage of fat in the milk.

In Series I., II. and III. *a*, when from 2.55 to 2.91 pounds of digestible protein were fed daily, the percentage of fat in the milk of each of the cows appears to be very even. Two cows show rather wide variations at times, but this can be accounted for only from the condition of the cow, and not from the food influence.

It is well known that the fat content of the milk will vary from time to time when the same fodder ration is fed.

TABLE VI.

Showing Average Results from Six Cows.

	Average Weight of Cows (Pounds).	AVERAGE DIGESTIBLE NUTRIENTS CONSUMED DAILY ON BASIS OF 1,000 POUNDS LIVE WEIGHT.*		Nutritive Ratio.	Total Amount of Milk produced on Basis 13 Per Cent. Solids (Pounds).	Total Solid Matter in Milk (Pounds).	Total Butter Fat in Milk (Pounds).	Average Per Cent. Total Solids in Milk.	Average Per Cent. Solids not Fat in Milk with 13 Per Cent. Solids.	Average Per Cent. Butter Fat in Milk with 13 Per Cent. Solids.
		Protein (Pounds).	Total Organic Matter (Pounds).							
Series I. *a*,	878	3.00	15.27	1:4.8	1,897.7	246.7	82.20	13.70	8.63	4.33
Series I. *b*,	867	1.50	15.27	1:10.0	1,685.8	219.25	67.66	13.47	9.01	3.99
Percentage increase *a* over *b*,	-	-	-	-	+12.6	+12.52	+21.49	+1.71	−4.10	+8.52
Series II. *a*,	871	2.93	15.65	1:4.8	1,731.3	225.0	78.44	13.80	8.47	4.53
Series II. *b*,	873	2.57	15.87	1:5.8	1,634.5	212.7	70.30	13.63	8.70	4.30
Percentage increase *a* over *b*,	-	-	-	-	+5.92	+5.78	+11.68	+1.25	−2.67	+5.85
Series III. *a*,	874	3.34	16.32	1:4.4	1,075.2†	139.77	45.30	13.73	8.80	4.20
Series III. *b*,	862	4.32	16.03	1:3.06	1,194.8†	155.31	50.76	13.77	8.75	4.25
Percentage increase *b* over *a*,	-	-	-	-	+11.1	+11.12	+12.05	±	±	+1.19

* Calculated from 871 pounds average weight.

† Nine-day period.

The above table presents the average results obtained from the six cows in each of the three series. The average weight of the herd remained quite constant during the four months' trial, showing a slight decrease in Series I. *b*, when a small amount of protein was fed, and another slight decrease in Series III. *b*, when a very large amount of protein was consumed. The total amount of organic matter fed in each series is practically the same, and, so far as the total digestible nutrients are concerned, the animals can be said to have been well nourished.

Series I. a and b.

The table shows that, with the same amount of total organic matter consumed daily, only one-half the digestible protein (1.50 pounds) was fed in ration *b* that was consumed in ration *a*.

The milk production in *b* decreased 12.60 per cent. on the basis of 13 per cent. solid matter, the total solid matter 12.52 per cent. and the total fat 21.49 per cent. The percentage decrease in the composition of the milk in *b* was in case of the total solids but 1.71 per cent., while in case of fat it was 8.52 per cent. with milk containing 13 per cent. solids. In this Series *a* the average results show the solids not fat were decreased only 4.10 per cent. Attention has already been called to the fact that some cows in this series showed a percentage decrease in the percentage of solids not fat of from 5 to 7 per cent.

The figures would seem to indicate that the lack of protein caused a decrease in the total milk yield, and also a decrease, although not so much, in the composition of the milk itself, especially in the fat content.

Series II. a and b.

The same is true of this series as of the former one. The variation in the protein supply is not so great, the difference being in the substitution of 3 pounds of corn meal for 3 pounds of Buffalo gluten feed. Ration *a*, when more protein was fed, produced 5.92 per cent. more milk with 13 per cent. solids and 5.78 per cent. more solid matter. The amount of fat increased 11.58 per cent. with ration *a*.

A percentage increase of 1.23 per cent. in the per cent. of total solids was noted, and a percentage increase of 5.35 per cent. in the per cent. of total fat on the basis of 13 per cent. solids.

It is quite possible that the high percentage of fat in the Buffalo gluten feed might have been instrumental in causing part, at least, of the increase in the fat percentage of the milk.

Series III. a and b.

In this series the amount of protein fed was very high. The maximum increase in the fat percentage in the milk appears to have been reached, for 4.32 pounds of protein did not seem to cause any increase in either the total solids or fat of the milk. Neither is any increase in the fat percentage to be noted in this period above the other periods, when 3 pounds of digestible protein were fed, being an indication at least that, other things being equal, more than 3 pounds of digestible protein daily ceases to exert any influence on the increase of fat in the milk.*

The increase in the protein supply, however, caused apparently 11.10 per cent. increase in the total yield of milk.

CONCLUDING OBSERVATIONS.

This experiment has some weak points, but it is believed they are not of such a serious nature as to interfere with its general teaching.

For example, the temperature of the stable was not a constant one, not being artificially heated. Again, the cows were divided into two lots, and one lot produced rather more milk daily than the other, but the difference was not excessive.

The milk should have been sampled for four or five days at least in every seven, instead of but for three days.

In the last series different coarse fodders were used from those fed in the two previous ones. The last series was of too short duration, and the first two series might have been at least a week longer. The daily supply of protein in each of the series should have been rather more regular in quantity, thus, 1.50, 2.00, 2.50, 3.00, 3.50 pounds, etc. Some rations contained more fat than others, which should have been avoided, for one cannot with certainty say that this increase in the fat supply of the food did not have an influence in increasing the fat in the milk.

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* In this series cow Hattie was substituted for Sarah. This cow gave milk of essentially the same fat content as did Sarah; still, it is not strictly fair to compare one series with another, for this reason.

The writer would of course draw no *particular conclusion* from this one experiment as to the effect of food, or any one group of food constituents, upon the quality of the milk. The results are simply presented just as they were found, and show what the six cows did in this particular case.

The experiment certainly indicates that rations so put together as to contain 2.5 to 3.5 pounds of digestible protein can be fed with greater profit to the farmer than rations containing 2 pounds.

The milk was principally affected in the first series, when the change from 1.5 to 3 pounds of digestible protein was made. If the change had been more gradual, it is possible that but little change in the milk would have been noted. It would have been interesting to note what the effect would have been on the milk composition if at the end of the three series the ration containing but 1.5 pounds of digestible protein had again been fed.

This experiment coincides with many previous investigations, only in our case the cows seemed to have been more generally affected by the different rations than in case of Kühn's or Wolff's various experiments.

DETAILS OF THE EXPERIMENT. — DAILY FEEDING RECORDS.

Nettie.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.								Dry Matter consumed per Day (Pounds).	Digestible Protein (Pounds).	Digestible Fat (Pounds).	Digestible Carbohydrates (Pounds).	Total Digestible Nutrients (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning and End of Periods (Pounds).
	Wheat Bran.	Buffalo Gluten Feed.	Chicago Gluten Meal.	Cotton-seed Meal.	Corn Meal.	Rowen.	Corn Stover.	Corn Ensilage.							
Series I. *a*, ...	3.00	3.00	-	3.00	-	-	4.00	46.11	21.06	2.59	1.14	9.87	13.60	1: 4.91	830-810
I. *b*, ...	4.50	-	-	-	4.50	-	4.00	43.04	19.99	1.32	0.70	11.43	13.45	1:10.00	820-835
II. *a*, ...	3.00	3.00	-	3.00	-	-	4.00	46.96	21.61	2.60	1.10	10.12	13.82	1: 4.95	835-840
II. *b*, ...	3.00	-	-	3.00	3.00	-	4.00	46.04	21.22	2.22	0.89	10.66	13.77	1: 5.81	810-827
III. *a*, ...	3.00	-	-	3.00	3.00	9.00	7.67	-	22.23	2.86	0.67	10.80	14.89	1: 4.36	827-820
III. *b*, ...	-	3.00	3.00	3.00	-	14.00	2.44	-	22.51	3.84	0.91	10.10	14.85	1: 3.24	817-827

Mary.

FEEDING PERIODS.	Wheat Bran.	Buffalo Gluten Feed.	Chicago Gluten Meal.	Cotton-seed Meal.	Corn Meal.	Rowen.	Corn Stover.	Corn Ensilage.	Dry Matter consumed per Day (Pounds).	Digestible Protein (Pounds).	Digestible Fat (Pounds).	Digestible Carbohydrates (Pounds).	Total Digestible Nutrients (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning and End of Periods (Pounds).
Series I. *a*, ...	3.00	3.00	-	3.00	-	-	4.00	48.00	20.26	2.59	1.13	10.12	13.84	1: 5.0	963-960
I. *b*, ...	4.50	-	-	-	4.50	-	4.00	52.61	21.98	1.39	0.77	12.54	14.70	1:10.4	990-995
II. *a*, ...	3.00	3.00	-	3.00	-	-	4.00	54.38	23.28	2.66	1.17	11.06	14.89	1: 5.25	992-982
II. *b*, ...	3.00	-	-	3.00	3.00	-	4.00	54.91	23.15	2.30	0.95	11.97	15.22	1: 6.24	977-960
III. *a*, ...	3.00	-	-	3.00	3.00	9.00	7.44	-	22.04	2.86	0.67	10.80	14.89	1: 4.36	945-925
III. *b*, ...	-	3.00	3.00	3.00	-	14.00	2.44	-	22.51	3.84	0.91	10.10	14.85	1: 3.24	925-940

DETAILS OF THE EXPERIMENT — *Concluded.*

Gem.

FEEDING PERIODS.	Feed Consumed (Pounds) per Day.								Dry Matter consumed per Day (Pounds).	Digestible Protein (Pounds).	Digestible Fat (Pounds).	Digestible Carbohydrates (Pounds).	Total Digestible Nutrients (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning and End of Periods (Pounds).
	Wheat Bran.	Buffalo Gluten Feed.	Chicago Gluten Meal.	Cotton-seed Meal.	Corn Meal.	Rowen.	Corn Stover.	Corn Ensilage.							
Series I. *a*,*	3.00	3.00	-	3.00	-	-	4.00	42.11	20.22	2.56	1.05	9.23	12.83	1:4.64	1037-1024
I. *b*, ...	4.50	-	-	-	4.50	-	4.00	43.30	20.04	1.31	0.67	11.22	13.20	1:9.84	1040-1030
II. *a*, ...	3.00	3.00	-	3.00	-	-	4.00	41.39	20.40	2.56	1.06	9.50	13.12	1:4.75	1020-1027
II. *b*, ...	3.00	-	-	3.00	3.00	-	4.00	42.09	20.36	2.18	0.85	10.10	13.13	1:5.61	995-1007
III. *a*, ...	3.00	-	-	3.00	3.00	9.00	6.60	-	21.36	2.81	0.66	9.92	13.39	1:4.12	1002-972
III. *b*, ...	-	3.00	3.00	3.00	-	14.00	1.67	-	21.87	3.82	0.90	9.53	14.25	1:3.08	975-1005

Sarah.

FEEDING PERIODS.	Wheat Bran.	Buffalo Gluten Feed.	Chicago Gluten Meal.	Cotton-seed Meal.	Corn Meal.	Rowen.	Corn Stover.	Corn Ensilage.	Dry Matter consumed per Day (Pounds).	Digestible Protein (Pounds).	Digestible Fat (Pounds).	Digestible Carbohydrates (Pounds).	Total Digestible Nutrients (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning and End of Periods (Pounds).
Series I. *b*, ...	4.50	-	-	-	4.50	-	4.00	33.89	17.96	1.22	0.63	10.09	11.94	1:9.56	755-772
I. *a*, ...	3.00	3.00	-	3.00	-	-	4.00	35.09	18.81	2.53	1.04	8.70	12.27	1:4.46	805-810
II. *b*, ...	3.00	-	-	3.00	3.00	-	4.00	39.00	19.72	2.21	0.86	10.05	13.12	1:5.52	820-815
II. *a*, ...	3.00	3.00	-	3.00	-	-	4.00	31.14	18.14	2.44	1.02	8.07	11.53	1·4.35	790-770
III. *b*,†	-	3.00	3.00	3.00	-	9.00	5.67	-	20.77	3.68	0.88	8.72	13.28	1:2.94	905-865
III. *a*, ...	3.00	-	-	3.00	3.00	14.00	2.11	-	22.05	2.97	0.69	10.17	14.03	1:4.00	863-885

Nora.

Series I. *b*, ...	4.50	-	-	-	4.50	-	4.00	44.36	20.14	1.31	0.71	11.89	13.41	1:10.00	813-800
I. *a*, ...	3.00	3.00	-	3.00	-	-	4.00	45.41	20.96	2.60	1.12	9.95	13.67	1: 4.09	825-845
II. *b*, ...	3.00	-	-	3.00	3.00	-	4.00	49.29	21.96	2.29	0.93	11.28	14.50	1: 5.94	825-825
II. *a*, ...	3.00	3.00	-	3.00	-	-	4.00	39.07	19.86	2.51	1.04	9.26	11.86	1: 4.73	812-825
III. *b*, ...	-	3.00	3.00	3.00	-	9.00	5.89	-	20.95	3.68	0.88	8.72	13.28	1: 2.94	805-785
III. *a*, ...	3.00	-	-	3.00	3.00	14.00	1.89	-	21.87	2.97	0.69	10.17	14.03	1: 4.00	840-850

Nellie.

Series I. *b*, ...	4.50	-	-	-	4.50	-	4.00	43.80	20.02	1.80	0.68	11.24	13.22	1:9.96	805-750
I. *a*, ...	3.00	3.00	-	3.00	-	-	4.00	45.66	21.01	2.60	1.09	9.88	13.57	1:4.84	815-812
II. *b*, ...	3.00	-	-	3.00	3.00	-	4.00	47.14	21.49	2.26	0.91	10.89	13.16	1:5.82	815-806
II. *a*, ...	3.00	3.00	-	3.00	-	-	4.00	44.86	21.13	2.55	1.07	9.82	13.44	1:4.90	775-785
III. *b*, ...	-	3.00	3.00	3.00	-	9.00	6.08	-	21.11	3.68	0.88	8.72	13.28	1:2.94	757-732
III. *a*, ...	3.00	-	-	3.00	3.00	14.00	2.03	-	21.98	2.97	0.69	10.17	14.03	1:4.00	766-792

* Period only eight days.

† Hattie, new cow.

Total Amounts of Feeds fed and Total Cost of Feed per Quart of Milk.

Nettie.

FEEDING PERIODS.	Quantity of Milk produced (Quarts).	Average Daily Yield (Quarts).	Wheat Bran consumed (Pounds).	Buffalo Gluten Feed consumed (Pounds).	Chicago Gluten Meal consumed (Pounds).	Cotton-seed Meal consumed (Pounds).	Corn Meal consumed (Pounds).	Rowen consumed (Pounds).	Corn Stover consumed (Pounds).	Corn Ensilage consumed (Pounds).	Total Cost of Feed consumed.	Cost of Feed per Quart of Milk produced (Cents).
Series I. *a*, ...	161.63	11.54	42.00	42.00	-	42.00	-	-	56.00	645.54	$2 29	1.42
I. *b*, ...	135.12	9.65	63.00	-	-	-	63.00	-	56.00	602.56	2 09	1.55
II. *a*, ...	148.60	10.61	42.00	42.00	-	42.00	-	-	56.00	637.44	2 28	1.53
II. *b*, ...	132.33	9.45	42.00	-	-	42.00	42.00	-	56.00	644.56	2 29	1.73
III. *a*, ...	75.35	8.37	27.00	-	-	27.00	27.00	81.00	69.03	-	1 64	2.18
III. *b*, ...	93.26	10.36	-	27.00	27.00	27.00	-	126.00	21.96	-	2 03	2.07

Mary.

FEEDING PERIODS.	Quantity of Milk produced (Quarts).	Average Daily Yield (Quarts).	Wheat Bran consumed (Pounds).	Buffalo Gluten Feed consumed (Pounds).	Chicago Gluten Meal consumed (Pounds).	Cotton-seed Meal consumed (Pounds).	Corn Meal consumed (Pounds).	Rowen consumed (Pounds).	Corn Stover consumed (Pounds).	Corn Ensilage consumed (Pounds).	Total Cost of Feed consumed.	Cost of Feed per Quart of Milk produced (Cents).
Series I. *a*, ...	160.00	11.16	42.00	42.00	-	42.00	-	-	56.00	592.06	$2 22	1.39
I. *b*, ...	136.51	9.75	63.00	-	-	-	63.00	-	56.00	736.54	2 26	1.65
II. *a*, ...	143.02	10.21	42.00	42.00	-	42.00	-	-	56.00	761.32	2 44	1.70
II. *b*, ...	115.51	8.26	42.00	-	-	42.00	42.00	-	56.00	768.74	2 44	2.12
III. *a*, ...	61.81	6.87	27.00	-	-	27.00	27.00	81.00	66.96	-	1 64	2.65
III. *b*, ...	80.47	8.94	-	27.00	27.00	27.00	-	126.00	21.96	-	2 03	2.52

Gem.

Series I. *a*,*	75.81	9.48	24.00	24.00	-	24.00	-	-	32.00	336.88	$1 27	1.67
I. *b*, ...	117.67	8.40	63.00	-	-	-	63.00	-	56.00	606.20	2 09	1.78
II. *a*, ...	130.47	9.32	42.00	42.00	-	42.00	-	-	56.00	579.46	2 21	1.69
II. *b*, ...	119.53	8.54	42.00	-	-	42.00	42.00	-	56.00	589.26	2 22	1.02
III. *a*, ...	67.21	7.47	27.00	-	-	27.00	27.00	81.00	59.49	-	1 62	2.41
III. *b*, ...	83.02	9.22	-	27.00	27.00	27.00	-	126.00	15.03	-	1 93	2.32

Sarah.

Series I. *b*, ...	116.51	8.32	63.00	-	-	-	63.00	-	56.00	474.46	$1 93	1.66
I. *a*, ...	122.56	8.75	42.00	42.00	-	42.00	-	-	56.00	491.26	2 10	1.71
II. *b*, ...	111.16	7.94	42.00	-	-	42.00	42.00	-	56.00	546.00	2 17	1.95
II. *a*, ...	100.93	7.21	42.00	42.00	-	42.00	-	-	56.00	435.96	2 03	2.01
III. *b*,†	119.58	13.28	-	27.00	27.00	27.00	-	81.00	51.03	-	1 68	1.40
III. *a*, ...	123.72	13.75	27.00	-	-	27.00	27.00	126.00	18.99	-	1 86	1.50

Nora.

Series I. *b*, ...	101.63	7.26	63.00	-	-	-	63.00	-	56.00	621.04	$2 11	2.08
I. *a*, ...	109.30	7.81	42.00	42.00	-	42.00	-	-	56.00	635.74	2 28	2.08
II. *b*, ...	102.09	7.29	42.00	-	-	42.00	42.00	-	56.00	690.06	2 35	2.30
II. *a*, ...	98.60	7.04	42.00	42.00	-	42.00	-	-	56.00	546.98	2 16	2.20
III. *b*, ...	66.05	7.34	-	27.00	27.00	27.00	-	81.00	53.01	-	1 69	2.55
III. *a*, ...	65.12	7.24	27.00	-	-	27.00	27.00	126.00	17.01	-	1 85	2.85

* Period only eight days.

† Hattie, new cow.

Total Amounts of Feeds fed and Total Cost of Feed per Quart of Milk — *Concluded.*

Nellie.

FEEDING PERIODS.	Quantity of Milk produced (Quarts).	Average Daily Yield (Quarts).	Wheat Bran consumed (Pounds).	Buffalo Gluten Feed consumed (Pounds).	Chicago Gluten Meal consumed (Pounds).	Cotton-seed Meal consumed (Pounds).	Corn Meal consumed (Pounds).	Rowen consumed (Pounds).	Corn Stover consumed (Pounds).	Corn Ensilage consumed (Pounds).	Total Cost of Feed consumed.	Cost of Feed per Quart of Milk produced (Cents).
Series I. *b*, ...	149.07	10.65	63.00	-	-	-	63.00	-	56.00	613.20	$2 10	1.41
I. *a*, ...	151.40	10.81	42.00	42.00	-	42.00	-	-	56.00	639.24	2 28	1.51
II. *b*, ...	144.42	10.32	42.00	-	-	42.00	42.00	-	56.00	659.96	2 31	1.60
II. *a*, ...	136.98	9.32	42.00	42.00	-	42.00	-	-	56.00	628.04	2 27	1.66
III. *b*, ...	82.56	9.17	-	27.00	27.00	27.00	-	81.00	54.72	-	1 69	2.05
III. *a*, ...	80.23	8.92	27.00	-	-	27.00	27.00	126.00	18.27	-	1 85	2.31

*Average Analyses of the Various Articles of Fodder.**

FODDER ANALYSES.	Wheat Bran.	Buffalo Gluten Feed.	Chicago Gluten Meal.	Cotton-seed Meal.	Corn Meal.	Rowen.	Corn Stover.	Corn Ensilage.
Dry Matter.								
Crude ash, . . .	7.01	0.94	0.14	7.31	1.29	7.62	7.14	4.53
" cellulose, . .	11.17	8.18	1.73	6.14	1.98	26.09	33.38	33.30
" fat, . . .	5.89	14.27	4.60	10.63	4.90	3.28	1.59	4.28
" protein, . .	17.92	23.45	37.09	48.64	11.07	14.42	9.91	6.31
Nitrogen-free extract .	58.01	53.16	56.44	27.28	80.76	48.59	47.98	51.58
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* Several lots of some of the different grains were purchased, but they varied so little in composition that only an average analysis is here presented.

Digestion Coefficients.

	Wheat Bran.	Buffalo Gluten Feed.	Chicago Gluten Meal.	Cotton-seed Meal.	Corn Meal.	Rowen.	Corn Stover.	Corn Ensilage.
Crude cellulose, . .	25	43	-	-	77	64	67	63
" fat, . . .	72	81	88	97	85	46	52	80
" protein, . .	78	85	87	88	72	62	52	53
Nitrogen-free extract, .	68	81	91	64	94	66	64	68

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5 cents, potassium oxide 5 cents, per pound.]

FERTILIZER ANALYSES.	Wheat Bran	Buffalo Gluten Feed.	Chicago Gluten Meal.	Cotton-seed Meal.	Corn Meal.	Rowen.	Corn Stover.	Corn Ensilage.
Moisture, ...	13.00	9.00	9.00	8.00	16.00	12.00	17.00	79.00
Nitrogen, ...	2.49	3.42	5.38	7.16	1.49	2.03	1.32	0.21
Phosphoric acid, . . .	2.46	0.35	0.42	2.37	0.70	0.62	0.05	0.03
Potassium oxide, . . .	1.58	0.06	0.07	1.70	0.40	1.83	1.82	0.41
Valuation per 2,000 pounds, .	$11 51	$10 67	$16 65	$25 55	$5 57	$8 54	$5 83	$1 05
Manurial value obtainable, .	9 21	8 54	13 32	20 44	4 46	6 83	4 66	0 84

Dry-matter Determinations of Foods Fed.

	Wheat Bran.	Buffalo Gluten Feed.	Chicago Gluten Meal.	Cotton-seed Meal.	Corn Meal.	Rowen.	Corn Stover.	Corn Ensilage.
Series I. { *a.* Cows 1, 2, 3, *b.* Cows 4, 5, 6, }	85.68	91.80	-	93.20	82.51	-	82.85	20.87
Series I. { *b.* Cows 1, 2, 3, *a.* Cows 4, 5, 6, }	87.35	91.80	-	93.20	83.59	-	82.85	20.87
Series II. { *a.* Cows 1, 2, 3, *b.* Cows 4, 5, 6, }	86.80	89.59	-	92.88	84.14	-	82.85	21.80
Series II. { *b.* Cows 1, 2, 3, *a.* Cows 4, 5, 6, }	86.80	89.50	-	91.46	83.94	-	82.85	21.80
Series III. { *a.* Cows 1, 2, 3, *b.* Cows 4, 5, 6, }	87.12	89.50	90.28	91.90	86.30	88.00	82.85	-
Series III. { *b.* Cows 1, 2, 3, *a.* Cows 4, 5, 6, }	87.60	89.00	91.00	92.80	86.30	88.00	82.00	-

Dry Matter in Refuse left in Mangers.

FEEDING PERIODS.	Nettie.	Mary.	Gem.	Sarah.	Nora.	Nellie.
Series I. *a*, ...	23.00	21.00	50.00	21.00	22.00	28.00
Series I. *b*, ...	19.00	19.00	38.00	22.00	21.00	23.00
Series II. *a*, ...	34.00	25.00	30.00	25.00	24.00	30.00
Series II. *b*, ...	31.00	21.00	39.00	21.00	26.00	32.00
Series III. *a*, ...	77.00	79.00	78.00	88.00*	80.00	81.00
Series III. *b*, ...	85.00	85.00	86.00	68.00*	72.00	72.00

* Hattie, new cow.

Average Composition of the Waste (Dry Matter).

	Per Cent.
Crude ash, ...	5.10
" cellulose, ...	39.00
" fat, ...	1.70
" protein, ...	6.70
Nitrogen-free extract, ...	47.50
	100.00

The waste in all of the periods was of the same character, viz., the coarser portion of the corn stalks from the corn stover and ensilage. The amount left by each of the cows in each series was carefully sampled and tested. It proved to be so identical in composition that one average analysis is given, which it is believed will fairly represent the composition of the whole.

Local Market Cost per Ton of the Various Articles of Fodder.

Wheat bran,	$19 00
Buffalo gluten feed,	19 00
Chicago gluten meal,	25 00
Cotton-seed meal,	26 00
Corn meal,	19 00
Rowen,	15 00
Corn stover,	5 00
Corn ensilage,	2 50

Temperature of Stable (Fahr.).

DATE.	Temperature.	DATE.	Temperature.
Series I., Jan. 16,	45	Series II., March 8,	47
17,	42	9,	50
18,	38	10,	55
19,	44	11,	54
20,	42	12,	52
21,	41	19,	62
22,	46	20,	55
23,	42	21,	50
24,	45	22,	53
25,	42	23,	48
26,	37	24,	45
27,	40	25,	49
28,	39	26,	42
29,	35	27,	42
Feb. 6,	35	28,	41
7,	38	29,	45
8,	46	30,	45
9,	45	31,	47
10,	46	April 1,	47
11,	43	Series III., April 8,	45
12,	36	9,	44
13,	34	10,	46
14,	34	11,	45
15,	37	12,	44
16,	34	13,	48
17,	30	14,	52
18,	43	15,	56
19,	42	16,	55
Series II., Feb. 27,	40	22,	59
28,	41	23,	59
March 1,	45	24,	58
2,	47	25,	58
3,	49	26,	60
4,	49	27,	65
5,	51	28,	64
6,	57	29,	61
7,	56	30,	63

3. CREAMERY RECORD OF THE STATION.

1893–94.

The cost of feed consumed is based on the market prices stated below. The valuation of the whole milk is taken at three cents per quart.

Local Market Cost per Ton of the Various Articles of Fodder.

Wheat bran,	$19 00
Buffalo gluten feed,	20 00
Peoria gluten feed,	20 00
King gluten meal,	25 00
Chicago gluten meal,	25 00
Cotton-seed meal,	26 00
New-process linseed meal,	28 00
Corn meal,	19 00
Corn and cob meal,	18 00
Mixed grains,	22 00
Hay,	15 00
Rowen,	15 00
Green fodder corn,	2 50
Corn stover,	5 00
Corn ensilage,	2 50
Soja-bean hay,	15 00
Vetch and oats (dry),	15 00
Barley straw,	10 00
Green rye,	2 50
Vetch and oats (green),	2 50
Hungarian grass (green),	2 50
Buckwheat (green),	2 50
Mixed green crops,	2 50
Potatoes,	2 50

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5 cents, potassium oxide 5 cents, per pound.]

FERTILIZER ANALYSES.	Moisture.	Nitrogen.	Phosphoric Acid.	Potassium Oxide.	Valuation per 2,000 Pounds.
Wheat bran,	11.00	2.48	2.85	1.63	$11 92
Buffalo gluten feed,	8.80	3.78	0.05	0.10	11 49
Peoria gluten feed,	8.50	3.50	0.05	0.10	10 65
King gluten meal,	7.80	5.69	0.69	0.08	17 84
Chicago gluten meal,	8.50	5.10	0.42	0.05	15 77
Cotton-seed meal,	8.00	6.47	2.75	1.98	24 14
New-process linseed meal,	11.00	5.83	1.95	1.08	20 52
Corn meal,	16.00	1.49	0.70	0.40	5 57
Corn and cob meal,	23.00	1.23	0.70	0.40	4 79
Mixed grains,	12.00	3.50	1.30	1.00	12 80
Hay,	15.00	1.47	0.27	1.50	6 18
Rowen,	12.00	1.72	0.47	1.63	7 26
Green fodder corn,	80.00	0.19	0.15	0.33	1 05
Corn stover,	17.00	1.32	0.05	1.82	5 83
Corn ensilage,	79.00	0.21	0.03	0.41	1 05
Soja-bean hay,	16.00	2.00	0.50	1.24	7 74
Vetch and oats (dry),	17.00	1.81	0.50	1.24	7 17
Barley straw,	13.00	0.86	0.12	2.60	5 30
Green rye,	72.00	0.30	0.12	0.64	1 66
Vetch and oats (green),	75.00	0.44	0.13	0.42	1 87
Hungarian grass (partly dry),	60.00	0.60	0.24	0.80	2 84
Buckwheat (green),	85.00	0.44	0.09	0.54	1 95
Mixed green crops,	80.00	0.43	0.15	0.35	1 79
Potatoes,	80.00	0.33	0.13	0.59	1 71

Fertilizing Constituents of Cream.

[Average analysis.]

	Per Cent.
Moisture at 100° C.,	72.00–74.00
Nitrogen (15 cents per pound),	0.54
Phosphoric acid (5 cents per pound),	0.17
Potassium oxide (5 cents per pound),	0.12

The monthly value placed upon the cream is the price paid for the same by the local creamery. The financial statement is based on the local cost of feed, and does not take into consideration interest on investment or cost of labor involved.

The results here presented are stated under the following separate headings : —

1. Statement of articles of fodder used.
2. Value of cream at creamery basis of valuation.
3. Cost of skim-milk on the basis of three cents per quart for whole milk.
4. Analyses of milk and cream.
5. What the creamery records show.

1. STATEMENT OF ARTICLES OF FODDER USED DURING 1893 (POUNDS).

1893.	Wheat Bran.	Buffalo Gluten Feed.	Cotton-seed Meal.	New-process Linseed Meal.	Hay.	Rowen.	Green Fodder Corn.	Corn Stover.	Corn and Soja-bean Ensilage.	Soja-bean and Corn Ensilage.	Serradella and Hungarian Grass Ensilage.	Soja-bean Hay.	Peas and Oats (Dry).	Vetch and Oats (Dry).	Barley Straw.	Vetch and Oats (Green).	Buckwheat (Green).	Vetch (Green).
January, .	489.00	489.00	442.00	-	1,080.00	-	-	742.50	2,968.50	-	-	-	-	-	-	-	-	-
February, .	504.00	504.00	491.00	-	798.00	-	-	-	7,084.00	-	-	-	-	-	-	-	-	-
March, .	516.00	516.00	507.00	-	721.00	-	-	-	9,108.00	-	-	-	-	-	-	-	-	-
April, .	507.00	507.00	426.00	-	781.00	-	-	-	2,530.00	1,370.00	4,751.00	-	-	-	-	-	-	-
May, . .	555.00	555.00	555.00	-	753.00	-	-	-	-	9,233.00	-	-	-	448.00	-	-	-	-
June, .	540.00	540.00	540.00	-	-	942.00	-	-	-	-	-	-	1,564.00	184.00	-	-	-	-
July, . .	558.00	558.00	409.50	130.50	-	1,820.00	-	-	-	-	-	-	-	-	-	3,880.00	-	-
August, .	558.00	558.00	-	558.00	-	2,726.00	-	-	-	-	-	-	-	-	-	-	633.00	252.00
September,	531.00	531.00	-	519.00	264.00	636.00	948.00	-	-	-	-	-	-	-	-	-	-	-
October, .	558.00	558.00	-	558.00	1,757.00	-	7,818.00	-	-	-	-	-	-	-	-	-	-	-
November,	540.00	540.00	-	540.00	-	-	-	-	-	-	-	-	129.00	2,877.00	-	-	-	-
December,	551.00	551.00	-	539.00	72.00	-	-	-	-	-	-	2,189.00	-	49.00	971.00	-	-	-

1. STATEMENT OF ARTICLES OF FODDER USED DURING 1894 (POUNDS).

1894.	Wheat Bran.	Buffalo Gluten Feed.	Peoria Gluten Feed.	King Gluten Meal.	Chicago Gluten Meal.	Cotton-seed Meal.	New-process Linseed Meal.	Corn Meal.	Corn and Cob Meal.	Mixed Grains.	Hay.	Rowen.
January, ...	679.00	292.00	-	-	-	236.00	52.00	368.00	-	-	162.00	-
February, ...	590.00	255.00	-	-	-	324.00	-	344.00	-	-	-	-
March, ...	558.00	279.00	-	-	-	558.00	-	279.00	-	-	-	-
April, ...	279.00	270.00	-	-	261.00	540.00	-	270.00	-	-	-	1,986.00
May, ...	765.00	-	-	322.00	317.00	126.00	-	126.00	-	-	-	1,452.00
June, ...	671.00	-	-	338.00	333.00	-	-	-	-	248.00	-	2,447.00
July, ...	233.00	233.00	-	233.00	-	-	-	-	-	364.00	-	1,305.00
August, ...	808.00	293.00	-	390.00	-	-	-	-	341.00	-	-	2,325.00
September, ...	732.00	-	416.00	227.00	-	-	-	-	36.00	-	-	690.00
October, ...	899.00	-	472.00	55.00	6.00	-	-	-	15.00	-	-	-

1. Statement of Articles of Fodder used during 1894 (Pounds) — *Concluded.*

1894.	Green Fodder Corn.	Corn Stover.	Corn Ensilage.	Soja-bean Hay.	Vetch and Oats (Dry).	Barley Straw.	Green Rye.	Vetch and Oats (Green).	Hungarian Grass (Green).	Buckwheat (Green).	Mixed Green Crops.	Potatoes.
January,	-	572.00	7,840.00	288.00	-	40.00	-	-	-	-	-	-
February,	-	672.00	8,610.00	-	-	-	-	-	-	-	-	-
March,	-	744.00	9,085.00	-	-	-	-	-	-	-	-	-
April,	-	1,170.00	295.00	-	-	-	-	-	-	-	-	-
May,	-	294.00	-	-	-	-	4,801.00	-	-	-	-	-
June,	-	-	-	-	-	-	-	1,525.00	-	-	580.00	-
July,	-	-	-	-	-	-	-	5,350.00	-	1,100.00	1,810.00	-
August,	3,630.00	-	-	-	-	-	-	-	-	-	-	-
September,	6,255.00	-	-	-	-	-	-	-	1,270.00	-	-	520.00
October,	-	1,410.00	-	390.00	288.00	-	-	-	3,186.00	-	-	1,920.00

2. VALUE OF CREAM AT CREAMERY BASIS OF VALUATION.

	Total Cost of Feed consumed.	Total Value of Fertilizing Constituents of Food consumed.	Value of Fertilizing Constituents lost in Cream.	Net Cost of Feed for Production of Cream.	Value of Cream produced.
1893.					
January, ...	$30 41	$22 81	$0 67	$12 83	$41 69
February, . . .	32 44	20 05	80	17 20	49 39
March, ...	35 07	24 91	91	16 05	56 32
April, ...	33 59	25 42	70	13 95	41 24
May, ...	40 29	27 98	70	18 61	38 95
June, ...	38 27	28 48	62	16 11	32 80
July, ...	36 81	26 34	61	16 35	31 57
August, ...	40 31	26 74	60	19 52	31 32
September, . . .	33 61	18 99	55	18 97	32 88
October, ...	41 57	28 68	61	19 24	36 32
November, . . .	40 10	30 93	55	15 91	32 72
December, . . .	39 56	26 75	51	18 67	30 76
Averages, . . .	$36 84	$25 67	$0 65	$16 95	$38 00
1894.					
January, ...	$31 43	$17 65	$0 70	$18 01	$36 97
February, . . .	28 08	16 33	60	15 62	31 35
March, ...	31 21	19 39	66	16 36	33 47
April, ...	33 90	23 31	61	15 86	28 56
May, ...	29 72	21 91	64	12 83	27 55
June, ...	38 47	22 06	59	21 41	24 92
July, ...	36 44	22 32	50	19 08	22 25
August, ...	40 49	21 12	62	24 21	30 28
September, . . .	29 42	16 71	47	16 52	25 29
October, ...	29 16	21 29	46	12 59	25 92
Averages, . . .	$32 83	$20 21	$0 59	$17 25	$28 66

3. COST OF SKIM-MILK ON THE BASIS OF THREE CENTS PER QUART FOR WHOLE MILK.

	Quarts of Milk produced.	Spaces of Cream.	Quarts of Cream (One Quart equals 3.4 Spaces).	Quarts of Skim-milk.	Value of Cream per Space (Cents).	Value of Cream per Quart of Milk (Cents).	Total Value of Cream.	Cost of Skim-milk per Quart (Whole Milk at Three Cents per Quart).	Total Cost of Skim-milk.
1893.									
January, .	1,625.2	981.0	288.5	1,336.5	4.25	2.57	$41 69	0.53	$7 06
February, .	2,007.4	1,176.0	345.9	1,651.5	4.20	2.46	49 39	0.66	10 88
March, . .	2,332.5	1,341.0	394.4	1,938.1	4.20	2.41	56 32	0.70	13 65
April, . .	2,008.7	1,031.0	303.2	1,705.5	4.00	2.05	41 24	1.11	19 02
May, . .	1,997.6	1,025.0	301.5	1,696.1	3.80	1.98	38 95	1.24	20 97
June, . .	1,668.6	911.0	267.9	1,400.7	3.60	1.96	32 80	1.23	17 25
July, . .	1,632.2	902.0	265.3	1,366.9	3.50	1.93	31 57	1.16	17 39
August, .	1,748.9	870.0	258.9	1,495.0	3.60	1.61	31 32	1.41	20 99
September, .	1,605.6	822.0	241.8	1,363.8	4.00	2.04	32 88	1.12	15 28
October, .	1,811.3	908.0	267.1	1,544.2	4.00	2.01	36 32	1.17	18 02
November, .	1,694.8	818.0	240.6	1,454.2	4.00	1.93	32 72	1.25	18 12
December, .	1,626.3	769.0	226.2	1,400.1	4.00	1.89	30 76	1.29	18 03
Averages, .	1,812.8	962.8	283.4	1,529.4	3.93	2.07	$38 00	1.07	$16 39
1894.									
January, .	1,879.5	973.0	286.2	1,593.3	3.80	1.97	$36 97	1.22	$19 42
February, .	1,569.3	836.0	253.8	1,315.5	3.75	2.00	31 35	1.20	15 78
March, . .	1,637.9	917.0	269.7	1,368.2	3.65	2.04	33 47	1.15	15 67
April, . .	1,639.2	850.0	250.0	1,389.2	3.36	1.74	28 56	1.48	20 62
May, . .	1,903.0	889.0	261.5	1,641.5	3.10	1.45	27 55	1.77	29 54
June, . .	1,905.1	817.0	240.3	1,664.8	3.05	1.31	24 92	1.94	32 23
July, . .	1,683.5	704.0	207.1	1,476.4	3.16	1.32	22 25	1.91	28 26
August, .	1,633.3	865.0	254.4	1,378.9	3.50	1.85	30 28	1.35	18 72
September, .	1,593.7	657.0	193.2	1,400.5	3.85	1.59	25 29	1.68	22 52
October, .	1,480.0	648.0	190.6	1,289.4	4.00	1.75	25 92	1.43	18 48
Averages, .	1,692.5	815.6	240.7	1,451.8	3.52	1.70	$28 66	1.51	$22 12

4. Analyses of Milk and Cream.

The station herd consisted of six cows of various grades, purchased in the vicinity, and are fair representatives of the cows kept by average farmers of this section. Here follows the monthly average of the composition of the milk.

As some of the cows were replaced by others during the year, no particular conclusions can be drawn relative to the difference in the solids and fat percentages.

	Total Solids.	Fat.
January,	13.49	4.33
February,	13.65	4.17
March,	13.71	4.66
April,	13.76	4.47
May,	13.49	3.93
June,	13.36	4.12
July,	13.48	4.44
August,	–	–
September,	13.85	3.87*
October,	–	4.47

* Cows not in good condition; fat percentage noticeably affected.

Composition of Cream.

The station cream, obtained by the Cooley process, when properly treated and the skim-milk carefully drawn, contains about 18.50 per cent. of fat.

5. What the Creamery Record Shows.

1. The nutritive ratio of the feed varied in 1893 from 1 : 3.50 to 1 : 5.00, with an average of 1 : 4.38; in 1894 from 1 : 4.50 to 1 : 5.50, with an average of 1 : 5.00.

2. The average monthly percentage of fat in the milk varied in 1893 from 4.37 to 4.84, with an average of 4.59; in 1894 from 3.87 to 4.47, with an average of 4.27.

3. The average monthly percentage of total solids varied in 1893 from 13.64 to 14.01, with an average of 13.84; in 1894 from 13.36 to 13.85, with an average of 13.60.

4. The relation of fat to solids not fat in 1893 was 1 : 2.02, while in 1894 it was 1 : 2.18.

5. The total cost of feed for one quart of cream amounted in 1893 to 13.00 cents and in 1894 to 13.64 cents.

6. The net cost of feed for one quart of cream amounted in 1893 to 5.98 cents and in 1894 to 7.17 cents.

7. The value received for one space of cream varied in 1893 from 3.50 to 4.25 cents, with an average of 3.93 cents; in 1894 from 3.10 to 4.00 cents, with an average of 3.52 cents, which amounted per quart (average) in 1893 to 13.36 cents, and in 1894 to 11.97 cents.

8. The number of quarts of milk required to produce one space of cream in 1893 was 1.88 and in 1894 2.08; or 6.39 quarts of whole milk to produce one quart of cream in 1893, and 7.07 quarts of whole milk to produce one quart of cream in 1894.

9. The net cost of feed per quart of cream averaged in 1893 5.98 cents and in 1894 7.17 cents. Received per quart of cream in 1893 13.36 cents and in 1894 11.97 cents, thereby securing a profit of 7.38 cents per quart in 1893 and 4.80 cents in 1894.

Our average statements for the current year apply in each case to only ten months, due to the fact that the financial settlement is made with our local creamery two months after the cream is furnished.

IV.

HAY SUBSTITUTES.

By J. B. Lindsey.

Vetch and Oats and Peas and Oats.

The many experiments made at this station have pointed out the costliness of English hay as a coarse fodder for milk production, and the substitution of other coarse fodders in its place. Among those fodders with which good success has been obtained may be mentioned vetch and oats and peas and oats. These fodders have given quite satisfactory results, both when fed green and when made into hay.

The results of two experiments may be cited. In one case rowen and hay of peas and oats were compared, and in another good English hay and hay of vetch and oats. The grain fed was constant in each case during the entire experiment.

I.

[Rowen *vs.* hay of peas and oats. Summer of 1893. Average results from four cows. Length of rowen period, 9 days; peas and oats period, 14 days.]

	Rowen.	Peas and Oats.
Average daily yield of milk, . . .	9.33 qts.	9.30 qts.
Average cost per quart, . . .	2.47 cts.	2.35 cts.

II.

[English hay *vs.* hay of vetch and oats. Autumn of 1894. Average results from six cows. Length of English hay period, 12 days; vetch and oats period, 34 days.]

	English Hay.	Vetch and Oats.
Average daily yield of milk, . . .	10.22 qts.	9.43 qts.
Average cost of milk per quart, . . .	2.25 cts.	2.35 cts.

In case of I. the yield and cost of milk are practically identical, while in II. the hay has slightly the advantage. This is, however, largely offset when it is noted (see summary above) that the vetch and oats period was four times as long as the hay period; cows would naturally shrink somewhat in their yield during this time. The cows gained in flesh during the vetch and oats period.

Yield per Acre of Vetch and Oats.

We have succeeded in raising on an average about three tons of hay per acre. It begins to bloom between the 25th of June and the 10th of July, depending of course on the season. It can be fed as a green fodder for some ten days, and the remainder made into hay, or it can be cut directly.

Several lots of seed can be sown some ten days apart in the spring, and green fodder thus secured for nearly a month.

After cutting the vetch and oats the land can be ploughed and planted to a second fodder crop. We followed vetch and oats this year with Hungarian grass, and in spite of the extremely dry season succeeded in getting one ton per acre of Hungarian hay. Had there been a fair amount of rainfall, this yield would certainly have been doubled. By this method four tons of hay per acre of an equal value with good English hay were secured. The land was manured with ten tons of barn-yard manure in the spring, and received no other fertilizer during the season. In place of the manure six hundred pounds of ground bone with two hundred pounds of muriate of potash would have answered the same purpose.

Seed per Acre.

It has been found that four bushels of oats and fifty pounds of vetch are about the right quantities and proportion for one acre. Both seeds are sown at the same time, and harrowed in. In our case an Acme harrow was used.

Composition of English Hay and Vetch and Oats compared.

Dry Matter.	English Hay.	Vetch and Oats.
Crude ash,	6.58	10.65
" cellulose,	30.33	35.95
" fat,	3.48	2.61
" protein,	11.10	13.42
Nitrogen-free extract,	48.51	37.37
	100.00	100.00

Digestibility.

The percentages of digestibility of the different ingredients in each of the above hays are the results of actual estimations at this station.

Coefficients of Digestibility.

	English Hay.	Vetch and Oats.
Crude cellulose,	60	66
" fat,	49	19
" protein,	60	58
Nitrogen-free extract,	60	54

Pounds of Digestible Matter in 2,000 Pounds of the Perfectly Dry Hays.

English hay,	1,113
Vetch and oats,	1,043

It will thus be seen that the vetch and oats furnish very nearly as much digestible matter in a ton as an extra quality of hay. The digestible protein in the vetch and oats is fully one per cent. higher than in the hay.

The hay grown upon the station grounds is of extra quality, having a considerable sprinkling of clover, and showing at best two per cent. more protein than the average hay grown upon New England farms.

Vetch and oats has the advantage over peas and oats in that the vetch stands up much better, and can be easily cut with a mowing machine. To secure the best results, the crops should be cut when in early to middle bloom. If cut when in late bloom the oats will have developed a considerable amount of woody fibre, rendering them less palatable and digestible.

V.

THE BABCOCK vs. THE "SPACE" SYSTEM, AS A BASIS FOR PAYMENT IN MASSACHUSETTS CREAMERIES.

By J. B. Lindsey.

By the Babcock system is meant the weighing of each patron's daily cream, raised or separated by whatever process, taking a fair sample of it, with a suitable sampler, preserving the daily samples, and once in ten days to two weeks testing this average sample for the percentage of butter fat by means of the Babcock tester. The percentage of butter fat found, multiplied by the pounds of cream, gives the pounds of butter fat actually in the cream.

The directors of the creamery, having a certain sum of money to divide, and knowing the total number of pounds of butter fat collected, divide the former amount by the latter; the quotient resulting represents the *price per pound* to be paid for the butter fat. The value of a pound of butter fat for the month having been in this way determined, is multiplied by the pounds of butter fat furnished by the patron, and the product represents the money he is entitled to each month for his cream. By this method the value of the cream is based entirely upon its content of butter fat.

The space system is familiar to all. The milk in deep-setting cans is submerged in ice water, and after a certain time the number of spaces of cream on each can is read by means of a strip of graduated glass set in the side of the can. A "space" is a circular volume of cream, $\frac{19}{64}$ of an inch thick, and 8½ inches in diameter. It is assumed by those who favor this system that a space of cream has comparatively the same value, no matter from what milk it is raised. A given quantity of poor milk may furnish fewer spaces than the same quantity of rich milk, it is argued, but the quality of the space would be equally as valuable for butter purposes.

The Babcock test as a basis for payment is used almost exclusively in the West. According to Professor Jordan,* the larger number of Maine creameries are using this system. In Vermont a very large portion of the milk and cream sold is paid for on the basis of butter fat it contains. In Connecticut the creameries are gradually adopting the Babcock system, and the writer has heard of several Massachusetts creameries employing it. Many inquiries have been made during the past year as to the comparative merits of the Babcock and the "space" systems, and the writer thought it advisable, therefore, to make an investigation, and to present the results obtained *as an object lesson* to those interested in this all-important branch of farm industry. Such an investigation had already been made by the Connecticut Experiment Station, and the results published in Bulletin 119. That station has recommended the Babcock system for general use in Connecticut creameries.

The Investigation.

The Cream collected and tested for Butter Fat.

The writer personally accompanied the cream gatherers of a large creamery in this locality, and took as fair a sample as possible of the cream of one hundred and sixty-five different patrons, by means of a small glass rod run into the mixed cream after the milk had been drawn, care being taken to draw off the milk as thoroughly as possible in each case. The sample of cream was run into small numbered glass bottles, and tested for butter fat by the Babcock method on the same day. The weight of the cream was also noted, as well as the number of spaces, and the temperature of the water in the tank. The result of this inquiry is presented in Table I.: —

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* See report of Prof. W. H. Jordan's lecture before Connecticut farmers in "New England Homestead," Feb. 15, 1894.

TABLE I.

COLUMNS —								
1	2	3	4	5	6	7	8	9
Number of Patron.	Spaces of Cream.	Pounds of Cream.	Per Cent. of Fat in Cream.	Pounds of Fat in Cream.	Pounds of Fat in 100 Spaces of Cream.	Value of Cream at 3.05 Cents per Space.	Value of Cream by Babcock Test at 21.83 Cents per Pound Butter Fat.	Payment by Babcock Test would give + or — than by Space System for 30 Days.
1	54	40.00	18.70	7.48	13.86	$1 65	$1 63	—$0 60
2	39	29.50	20.00	5.99	15.35	1 19	1 31	+3 60
3	20	15.00	17.10	2.56	12.80	61	56	—1 50
4	80	61.75	16.90	10.43	13.04	2 44	2 28	—4 80
5	8	6.25	20.00	1.25	15.62	24	27	+ 90
6	28	23.25	15.70	3.65	13.00	85	79	—1 80
7	34	24.25	21.60	5.23	15.41	1 04	1 14	+3 00
8	20	15.00	15.00	2.25	11.25	61	49	—3 60
9	29	22.00	18.10	3.98	13.74	88	87	— 30
10	10	8.50	18.00	1.53	15.30	30	33	+ 90
11	26	20.00	18.90	3.78	14.54	79	82	+ 90
12	57	43.25	17.20	7.44	13.05	1 74	1 62	—3 60
13	8	7.00	16.80	1.17	14.70	24	26	+ 60
14	24	19.00	21.40	4.06	16.98	73	89	+4 80
15	89	60.75	19.80	13.81	15.52	2 71	3 01	+9 00
16	77	57.50	17.80	10.23	13.29	2 35	2 23	—3 60
17	67	52.50	19.00	9.97	14.89	2 04	2 17	+3 90
18	47	37.50	16.70	6.26	13.32	1 43	1 37	—1 80
19	35	26.25	16.00	4.38	12.52	1 07	95	—3 60
20	108	82.75	19.00	15.72	14.56	3 29	3 43	+4 20
21	67	53.25	19.60	10.44	15.57	2 04	2 28	+7 20
22	51	38.00	20.20	7.68	15.04	1 56	1 68	+3 60
23	48	39.00	16.70	6.51	13.56	1 46	1 42	—1 20
24	68	47.75	19.70	9.40	13.82	2 07	2 05	— 60
25	28	23.00	20.20	4.65	16.60	85	1 01	+4 80
26	37	27.50	20.20	5.55	15.00	1 13	1 21	+2 40
27	42	33.00	18.50	6.10	14.54	1 28	1 33	+1 50
28	32	24.50	17.10	4.19	13.10	98	91	—2 10
29	14	14.25	14.60	2.08	14.80	43	45	+ 60
30	22	19.50	17.10	3.33	15.16	67	73	+1 80
31	15	11.25	18.50	2.08	13.87	46	45	— 30
32	29	22.75	17.10	3.89	13.42	88	85	— 90

Table I. — *Continued.*

Columns —								
1	2	3	4	5	6	7	8	9
Number of Patron.	Spaces of Cream.	Pounds of Cream.	Per Cent. of Fat in Cream.	Pounds of Fat in Cream.	Pounds of Fat in 100 Spaces of Cream.	Value of Cream at 3.05 Cents per Space.	Value of Cream by Babcock Test at 21.83 Cents per Pound Butter Fat.	Payment by Babcock Test would give + or — than by Space System for 30 Days.
33	24	19.25	18.2	3.53	14.71	$0 73	$0 77	+$1 20
34	25	21.25	19.3	4.10	16.40	76	89	+3 90
35	37	30.25	19.3	5.83	17.58	1 13	1 27	+4 20
36	182	126.75	17.2	21.80	12.00	5 55	4 76	—23 70
37	70	50.50	18.5	9.34	13.34	2 14	2 04	—3 00
38	48	35.50	19.1	6.84	14.24	1 46	1 49	+ 20
39	24	16.50	21.6	3.62	15.18	73	79	+1 80
40	28	19.00	18.6	3.53	12.62	85	76	—2 70
41	80	58.63	18.6	10.91	13.63	2 44	2 38	—1 80
42	42	34.00	11.0	3.74	8.90	1 28	82	—13 80
43	64	48.75	20.4	9.94	15.53	1 95	2 17	+6 60
44	35	27.40	19.8	5.46	15.61	1 07	1 19	+3 60
45	30	24.00	20.5	4.92	16.40	92	1 07	+4 50
46	18	15.50	17.2	2.66	15.41	55	58	+ 90
47	23	18.75	14.4	2.73	11.87	70	60	—3 00
48	41	32.25	18.3	5.90	14.39	1 25	1 29	+1 20
49	35	27.50	18.3	5.08	14.37	1 07	1 10	+ 90
50	84	66.75	18.3	12.21	14.54	2 56	2 66	+3 00
51	40	31.25	16.2	5.08	12.72	1 22	1 12	—3 00
52	24	22.00	17.3	3.80	15.83	73	83	+3 00
53	29	22.75	17.9	4.02	13.80	88	88	±
54	17	12.50	20.2	2.52	14.85	52	55	+ 90
55	20	15.50	20.4	3.16	15.81	61	69	+2 40
56	26	20.00	19.3	3.86	14.85	79	84	+1 50
57	17	14.75	15.3	2.26	13.27	52	49	— 90
58	24	18.00	20.0	3.60	15.00	73	78	+1 50
59	105	85.63	19.2	16.44	15.66	3 20	3 59	+11 70
60	136	97.50	21.5	20.96	15.41	4 15	4 57	+12 60
61	28	20.00	19.5	3.90	13.93	85	85	±
62	25	20.00	16.0	3.20	12.80	76	70	—1 80
63	14	10.75	18.3	1.97	14.00	43	43	±
64	57	43.50	18.2	7.91	13.88	1 74	1 73	— 30

TABLE I. — *Continued.*

Columns —								
1	2	3	4	5	6	7	8	9
Number of Patron.	Spaces of Cream.	Pounds of Cream.	Per Cent. of Fat in Cream.	Pounds of Fat in Cream.	Pounds of Fat in 100 Spaces of Cream.	Value of Cream at 3.05 Cents per Space.	Value of Cream by Babcock Test at 21.83 Cents per Pound Butter Fat.	Payment by Babcock Test would give + or — than by Space System for 30 Days.
65	21	17.00	18.6	3.16	15.90	$0 64	$0 69	+$1 50
66	24	15.50	19.0	2.94	12.27	73	64	—2 70
67	29	21.50	18.4	3.95	13.64	88	86	— 60
68	17	13.25	17.2	2.27	13.41	52	50	— 60
69	20	15.00	19.1	2.86	14.32	61	62	+ 30
70	14	11.00	17.5	1.92	13.75	43	42	— 30
71	33	22.00	18.6	4.09	12.40	1 01	89	—3 60
72	22	13.50	21.0	2.83	12.89	67	62	—1 50
73	36	32.00	15.3	4.89	13.60	1 10	1 07	— 90
74	26	20.00	20.3	4.06	15.62	79	89	+3 00
75	21	17.00	16.5	2.80	13.35	64	61	— 90
76	47	33.50	20.9	7.00	14.90	1 43	1 53	+3 00
77	30	21.50	17.8	3.82	12.76	92	83	—2 70
78	38	26.50	19.4	5.14	13.53	1 16	1 12	—1 20
79	70	52.75	17.8	9.39	13.41	2 14	2 05	—2 70
80	27	20.50	17.3	3.54	13.13	82	77	—1 50
81	127	94.50	17.6	16.63	13.09	3 87	3 63	—7 20
82	31	21.25	20.2	4.29	13.85	95	94	— 30
83	9½	6.00	19.6	1.17	12.38	29	26	— 90
84	31	24.00	19.0	4.56	14.71	95	1 00	+1 50
85	7	5.00	19.2	0.96	13.71	21	21	±
86	17	12.50	22.0	2.75	16.18	52	60	+2 40
87	49	34.00	18.2	6.18	12.63	1 49	1 35	—4 20
88	22	16.80	17.7	2.97	13.51	67	65	— 60
89	39	32.00	15.0	4.80	12.31	1 19	1 05	—4 20
90	25	20.25	16.4	3.32	13.28	76	72	—1 20
91	28	22.50	16.7	3.75	13.42	85	82	— 90
92	29	25.00	18.8	4.70	16.21	88	1 03	+4 50
93	29	22.50	16.8	3.78	13.04	88	82	—1 80
94	46	37.75	17.7	6.68	14.52	1 40	1 46	+1 80
95	10	9.25	11.2	1.03	10.36	31	22	—2 70
96	58	46.00	16.9	7.77	13.40	1 77	1 70	—2 10

TABLE I. — *Continued.*

COLUMNS —								
1	2	3	4	5	6	7	8	9
Number of Patron.	Spaces of Cream.	Pounds of Cream.	Per Cent. of Fat in Cream.	Pounds of Fat in Cream.	Pounds of Fat in 100 Spaces of Cream.	Value of Cream at 3.05 Cents per Space.	Value of Cream by Babcock Test at 21.83 Cents per Pound Butter Fat.	Payment by Babcock Test would give + or — than by Space System for 30 Days.
97	42	34.00	18.2	6.19	14.73	$1 28	$1 35	+$2 10
98	58	44.00	20.2	8.89	15.31	1 77	1 94	+5 10
99	28	23.75	18.0	4.27	15.27	85	93	+2 40
100	29	21.50	15.2	3.27	11.27	88	71	—5 10
101	21	18.63	16.4	3.05	14.55	64	67	+ 90
102	38	27.00	17.9	4.83	12.72	1 16	1 05	—3 30
103	9	8.75	15.6	1.36	15.17	27	30	+ 90
104	14	9.75	21.6	2.10	15 00	43	46	+ 90
105	25	16.80	20.2	3.33	13.32	76	73	— 90
106	15	10.25	17.1	1.75	11.68	46	38	—2 40
107	14	12.25	18.2	2.23	15.92	43	49	+1 80
108	56	41.50	18.3	7.59	18.56	1 71	1 66	—1 50
109	61	48.75	17.8	8.68	14.22	1 86	1 89	+ 90
110	14	12.50	17.2	2.15	15 36	43	47	+1 20
111	12	9.00	17.0	1.53	12.75	37	33	—1 20
112	13	10.75	16.4	1.76	13.56	40	38	— 60
113	13	9.75	16.7	1.62	12.52	40	35	—1 50
114	22	15.00	17.0	2.55	11.59	67	56	—2 70
115	12	10.25	16.4	1.68	14.00	37	37	±
116	21	14.50	20.9	3.13	14.93	64	68	+1 20
117	13	9.75	19.5	1.90	14.62	40	41	+ 30
118	19	14.50	21.4	3.10	16.33	58	68	+3 00
119	52	40.75	19.0	7.74	14.89	1 59	1 69	+3 00
120	51	38.00	18.4	6.99	13.71	1 56	1 53	— 90
121	48	35.50	18.8	6.67	13.90	1 46	1 45	— 30
122	51	42.25	17.9	7.56	14.82	1 56	1 66	+3 00
123	10	8.50	16.8	1.43	14.28	31	31	±
124	28	22.50	16.5	3.71	13.26	85	82	— 90
125	9	9.50	16.7	1.58	17.63	27	34	+2 10
126	38	26.50	20.1	5.33	14.02	1 16	1 16	±
127	29	23.00	17.0	3.91	13.48	88	85	— 90
128	38	25.50	17.2	4.39	11.54	1 16	96	—6 00

TABLE I. — *Continued.*

COLUMNS —								
1	2	3	4	5	6	7	8	9
Number of Patron.	Spaces of Cream.	Pounds of Cream.	Per Cent. of Fat in Cream.	Pounds of Fat in Cream.	Pounds of Fat in 100 Spaces of Cream.	Value of Cream at 3.05 Cents per Space.	Value of Cream by Babcock Test at 21.83 Cents per Pound Butter Fat.	Payment by Babcock Test would give + or — than by Space System for 30 Days.
129	7	7.25	15.10	1.09	15.64	$0 21	$0 24	+$0 90
130	25	19.25	15.50	2.98	11.93	76	65	—3 30
131	15	11.00	17.50	1.92	12.83	46	42	—1 20
132	8	7.75	15.80	1.22	15.31	24	27	+ 90
133	11	9.00	15.00	1.35	12.27	34	29	—1 50
134	12	10.00	17.40	1.74	14.50	37	38	+ 30
135	10	8.50	14.10	1.19	11.98	31	26	—1 50
136	7	5.25	16.30	0.86	12.22	21	19	— 60
137	41	32.25	17.80	5.74	14.00	1 25	1 26	+ 30
138	10	8.25	17.60	1.45	14.52	31	32	+ 30
139	15	13.50	14.50	1.96	13.05	46	43	— 90
140	11	9.50	14.50	1.37	12.52	34	30	—1 20
141	13	10.25	16.20	1.66	12.77	40	36	—1 20
142	11	8.50	18.00	1.53	13.91	34	33	— 30
143	43	34.63	17.80	6.14	14.29	1 31	1 34	— 90
144	35	29.50	15.70	4.63	13.23	1 07	1 01	—1 80
145	54	41.50	19.60	8.13	15.04	1 65	1 78	+3 90
146	56	42.00	19.50	8.19	14.63	1 71	1 79	+2 40
147	18	14.00	17.50	2.45	13.61	55	53	— 60
148	24	19 75	17.80	3.51	14.23	73	77	+1 20
149	30	26.00	17.20	4.47	13.91	92	98	+1 80
150	26	19.50	18.10	3.53	13.58	79	77	— 60
151	35	26.75	19.60	5.24	14.98	1 07	1 14	+2 10
152	6	3.50	18.80	0.66	10.97	18	14	—1 20
153	36	26.00	18.00	4.68	13.00	1 10	1 02	—2 40
154	62	45.50	18.80	8.55	13.79	1 89	1 87	— 60
155	18	15 50	16.40	2.54	14.12	55	55	±
156	18	13.50	17.95	2.42	13.46	55	53	— 60
157	16	12.50	19.00	2.37	14.84	49	52	+ 90
158	19	18.00	14.40	2.59	13.64	58	56	— 60
159	22	16.00	19.40	3.10	14.11	67	68	+ 30
160	26	18.50	18.00	3.33	12.69	79	73	—1 80

TABLE I. — *Concluded.*

COLUMNS —								
1	2	3	4	5	6	7	8	9
Number of Patron.	Spaces of Cream.	Pounds of Cream.	Per Cent. of Fat in Cream.	Pounds of Fat in Cream.	Pounds of Fat in 100 Spaces of Cream.	Value of Cream at 3.05 Cents per Space.	Value of Cream by Babcock Test at 21.83 Cents per Pound Butter Fat.	Payment by Babcock Test would give + or − than by Space System for 30 Days.
161	21	16.5	12.80	2.11	10.06	$0 64	$0 46	−$5 40
162	51	37.0	19.60	7.25	14.22	1 56	1 59	+ 90
163	55	44.5	15.70	6.98	12.70	1 68	1 53	−4 50
164	55	46.5	18.00	8.37	15.22	1 68	1 83	+4 50
165	37	28.5	18.80	5.36	14.48	1 13	1 17	+1 20
	5,659	-	-	790.77	-	$172 61	$172 60	-

Comments on Table I.

Column 1 represents the number of each patron; column 2, the number of spaces; column 3, the pounds of cream; column 4, the per cent. of fat in cream; column 5, the pounds of fat actually furnished by each patron in one day's cream. Column 6, showing the pounds of butter fat in 100 spaces of each patron's cream, is calculated for the sake of comparison. Column 7 represents the value of the cream at the price per space paid by the creamery at the time. Column 8 shows the value of the cream by Babcock test, on the basis of 21.83 cents per pound of butter fat. This value per pound of fat was determined by taking the value of the cream as represented by the space system, and dividing it by the number of pounds of butter fat actually found in the cream. The quotient showed the price per pound of butter fat. Column 9 shows whether payment by the Babcock test would be more or less than by the space system for thirty days.

It will be seen that the percentage of fat in the cream varies very much. The extremes are 11 and 22 per cent.

The pounds of butter fat in 100 spaces of each patron's cream differ also widely, the extreme being 8.90 pounds and 17.63 pounds.

Attention is also called to the last column, which makes emphatic that by the Babcock system those patrons furnishing the better to best qualities of cream would be paid more, and those furnishing the poorer qualities would be paid less, than by the present system.

Summary of Table I., showing Butter Equivalent from 100 Spaces of Graded Cream, and Value of Same.

Pounds of Butter Fat from 100 Spaces of Cream.	Number of Patrons.	Per Cent. of Patrons.	Equivalent to Butter. — Pounds.	Value of Butter at 25 Cents per Pound.
8-12, ...	10	6.1	13.42*	$3 35
12-13, ...	23	14.0	14.58	3 64
13-14, ...	52	31.5	15.75	3 94
14-15, ...	41	24.9	16.92	4 23
15-16, ...	30	18.2	18.08	4 52
16-18, ...	9	5.5	19.83	4 96

* Figured on the basis of 11.5 pounds of butter fat.

This summary gives us at least a comparative idea of the different qualities of cream furnished, and their approximate values in butter. It brings out the variations in a very striking manner, and needs no further explanation.

Is the Weight of the "Space" Constant?

In order to show the variations, the weight per space of the cream collected from thirty-six different patrons on two consecutive days is given in Table II. Beginning from the left, each fraction of a pound shows the weight of a space of each patron's cream.

TABLE II.

First Day.

	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
Patrons 1-9, ...	.713	.948	.682	.785	.802	.833	.662	.695	.714
" 10-18, ...	.840	.760	.768	.750	.705	.685	.775	.704	.758
" 19-27, ...	.766	.743	.786	.788	.809	.716	-	.720	.773
" 28-36, ...	.800	.971	.875	.725	.785	.765	.862	.792	.709

Average weight of a space, ...750 pounds.

TABLE II. — *Concluded.*

Second Day.

	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
Patrons 1-9, ...	.741	.756	.750	.772	.781	.830	.713	.750	.758
" 10-18, ...	.850	.770	.759	.875	.791	.783	.747	.784	.798
" 19-27, ...	.750	.766	.795	.745	.813	.702	.822	.743	.786
" 28-36, ...	.766	1.020	.887	.750	.785	.802	.850	.818	.696

Average weight of a space, ...766 pounds.

Comments on Table II.

Having noted in Table I. the data, showing the wide differences existing in the *composition* of the space as furnished by different patrons, one has only to examine Table II. to note equally as wide differences in the *weight* of the space. One could not fail to note these differences when weighing the different lots of cream, twenty-five spaces from one patron often showing a different weight from a like amount furnished by another.

Is the Babcock test reliable?

Can a pound of butter always be made from the same number of spaces?

In order to illustrate these points, the cream of three patrons was churned separately. No. 1 was a poor cream, No. 2 a good cream and No. 3 a cream of fair quality. The cream was weighed, the number of spaces noted, as well as the per cent. of butter fat it contained. The butter produced from each cream was also weighed, as well as the buttermilk, and tested for the per cent. of butter fat. The per cent. of water in each of the different samples of butter was also determined.

TABLE III. — *Showing Results of the Test.*

NUMBER.	Number of Spaces.	Weight of Cream (Pounds).	Per Cent. of Fat in Cream.	Pounds of Fat in Cream.	Pounds of Butter made.	Per Cent. of Fat in Butter.	Pounds of Fat in Butter.	Pounds Buttermilk.	Pounds Fat in Buttermilk.	Total Fat in Butter and Buttermilk.
1, ...	17	14	12.0	1.68	2.50*	61.45	1.53	17.5	0.14	1.67
2, ...	25	17.5	20.4	3.57	4.50	76.73	3.45	15.0	0.05	3.50
3, ...	25	19.5	17.0	3.32	4.25	75.30	3.20	33.5	0.03	3.23

* Not salted, but equal to about 2.60 pounds salted butter.

The above table shows the reliability of the Babcock test. Please notice that in the cream churned there were 1.68, 3.57 and 3.32 pounds of butter fat respectively, and we accounted for by means of this test 1.67 pounds, 3.50 pounds and 3.23 pounds. In the process of manipulation small fractions are of course lost; the results, however, tally very closely, and as near as one could expect or ask for.

Composition of the Butter.

	No. 1.*	No 2.	No. 3.
Water, ...	31.85	13.61	17.80
Fat, ...	58.48	76.73	75.30
Salt and curd, ...	9.67	9.67	6.90

* Calculated on salt and curd basis of No. 2; this butter was not salted.

Attention is called to the very large amount of water in No. 1, and the consequent low percentage of butter fat. The butter maker reported that it was impossible to work out more water. The butter had a very inferior appearance. Numbers 2 and 3 looked well.

Spaces to the Pound.

(*a*) *Butter Maker's Report.*

	I.	II.	III.
Spaces per pound salted, . . .	6.41	5.55	5.88

(*b*) *On the Basis of Same Amount of Water as found in No. II.*

Spaces per pound salted, . . .	8.29	5.55	6.19

These results make very clear that, other things being equal, the number of spaces required to make a pound of butter of *like water content* depends entirely upon the amount of butter fat in the cream; and it is very strange that farmers will be so blind to their own interest as to fail to recognize this fact. Cream will make butter *in proportion to the amount of butter fat it contains.*

CONCLUSIONS.

The results obtained fully confirm the investigations made along this line elsewhere.

They show conclusively that the space of cream is of very variable composition, and is not a true measure of the value of cream for butter purposes. The value of cream for butter, other things being equal, depends entirely upon the amount of butter fat it contains. The number of spaces of cream required to make a pound of butter depends also upon the butter fat content of the cream.

The Babcock test is perfectly reliable, and this system can be applied practically to determine the value of cream raised by the deep-setting process.

VI.

I. FIFTH FEEDING EXPERIMENT WITH STEERS.

By J. B. Lindsey.

1893–94.

General Description.

The experiment here described is a continuation of those published in our previous reports.

Three grade Durham steers, yearlings, weighing about 600 pounds each, were used in the experiment. They were quite thin when first received, and cost 3 69 cents per pound live weight.

The coarse foods fed were raised upon the station grounds, and consisted principally of corn ensilage, corn stover, vetch and oats and a variety of green crops with some roots. The corn for ensilage was cut just as the kernels were glazing. The corn stover was the corn plant remaining after the fully matured ears had been removed. The grains fed were wheat bran, Buffalo gluten feed, new-process linseed meal, corn and cob meal, cotton-seed meal and oat feed. The quantity of coarse fodders fed depended in all cases upon the individual appetite of the animals

The animals were fed and watered twice each day, between six and seven o'clock in the morning and at five in the afternoon, one-half of the food being given at each time. About one ounce of salt was added to the grain feed daily. Whenever the weather permitted, the steers were allowed the use of the barn-yard for at least one-half a day. They were kept well carded.

The weights of the animals were taken weekly, before being watered in the morning.

The Reasons for the Experiment.

I. To note the effect of distinct fodder rations upon the production of live weight.

II. To secure facts relating to the actual cost of beef production in Massachusetts under existing local conditions.

III. To compare the relative merits and cost of pasture *vs.* soiling during the summer season.

I. Effect of Distinct Fodder Rations upon the Production of Live Weight.

Average Composition of the Daily Fodder Rations (1893–94).

I		II.	
May 16 to June 8.		*June 21 to July 4.*	
Buffalo gluten feed,	3 00 lbs.	Buffalo gluten feed,	3 00 lbs.
New-process linseed meal,	2 00 "	New-process linseed meal,	2.00 "
Soja-bean and corn ensilage,	39 38 "	Rowen,	14 00 "
Nutritive ratio,	1 : 5.51	Nutritive ratio,	1 : 4.64
Total cost,	10 86 cts.	Total cost,	15.95 cts.
Manurial value obtainable,	6 99 "	Manurial value obtainable,	9 32 "
Net cost,	3.87 "	Net cost,	6.63 "

III.		IV.	
November 7 to November 20.		*November 28 to January 2.*	
Wheat bran,	3.00 lbs.	Wheat bran,	3 00 lbs.
New-process linseed meal,	3.00 "	New-process linseed meal,	3.00 "
Corn stover,	15.33 "	Corn stover,	12.07 "
Nutritive ratio,	1 : 6 29	Roots,*	15.00 "
Total cost,	10.57 cts.	Nutritive ratio,	1 : 6.10
Manurial value obtainable,	10.18 "	Total cost,	12.75 cts.
Net cost,	0.39 "	Manurial value obtainable,	10 45 "
		Net cost,	2.30 "

V.		VI.	
January 27 to February 11.		*March 1 to March 27.*	
Buffalo gluten feed,	4.00 lbs.	Cotton-seed meal,	4.00 lbs.
Oat feed,	4.00 "	Corn and cob meal,	4.00 "
Corn stover,	4.00 "	Corn stover,	4.00 "
Corn ensilage,	28.91 "	Corn ensilage,	42.39 "
Turnips,	15.00 "	Nutritive ratio,	1 : 6.25
Nutritive ratio,	1 : 8.73	Total cost,	15.30 cts.
Total cost,	15.49 cts.	Manurial value obtainable,	10 10 "
Manurial value obtainable,	10.61 "	Net cost,	5.20 "
Net cost,	4.88 "		

* Potatoes or mangolds.

Summary of Cost of the Average Daily Fodder Rations.

[Cents.]

	FEEDING PERIODS.					
	I.	II.	III.	IV.	V.	VI.
Total cost,	10.86	15.95	10.57	12.75	15.49	15.30
Manurial value obtainable,*	6.99	9.32	10.18	10.45	10.61	10.10
Net cost,	3.87	6.63	0.39	2.30	4.88	5.20

Gain required per Day in Pounds of Live Weight to cover Cost of Feed.

	I.	II.	III.	IV.	V.	VI.
Total cost,	2.82	4.14	2.74	3.31	4.02	4.00
Net cost,	1.00	1.72	0.10	0.60	1.27	1.35

Live Weight actually produced per Day.

	I.	II.	III.	IV.	V.	VI.
	1.50	0.88	0.93	0.95	1.87	0.81

Cost of Feed per Pound of Live Weight gained.

	I.	II.	III.	IV.	V.	VI.
Total cost,	7.24	18.01	11.36	13.42	8.29	18.88
Net cost,	2.58	7.53	0.43	2.42	2.61	6.42

* Allowing 90 per cent. of the fertilizing ingredients to be recovered in the manure.

The periods in which ensilage was fed as the coarse fodder produced distinctly the largest gains in live weight. The hay ration (Period II.) was the most costly one.

II. WHAT IT HAS COST TO PRODUCE BEEF.

Below is presented a detailed account of the cost of the foods consumed. The cost of labor, interest on the money involved, etc., is not added.

The steers were purchased March 28, 1893, at 3.69 cents per pound live weight, and were sold April 4, 1894, for 3.85 cents per pound live weight. It is to be noted that these animals were bought when beef was high and of necessity sold when it was low, which will naturally not be favorable to a successful financial operation. They were soiled during the summer of 1893.

The three steers consumed nearly the same amount of food, only slight differences being noted in the coarse fodders.

Record of Feed consumed.

[Average.*]

FODDER ARTICLES.	Feed consumed (Pounds).	Dry Matter (Pounds).	Local Market Cost.	Manurial Value Obtainable.	Net Cost.
Wheat bran,	675	600.75	$6 41	$3 98	$2 43
Buffalo gluten feed,	476	437.92	4 52	2 70	1 82
New-process linseed meal,	705	630.13	9 52	7 47	2 05
Cotton-seed meal,	168	154.56	2 26	2 13	13
Corn and cob meal,	161	123.97	1 45	47	98
Oat feed,	96	89.28	91	34	57
Rowen,	869	770.80	6 51	3 37	3 14
Soja-bean and corn ensilage,	2,569	570.03	3 52	2 04	1 48
Corn ensilage,	2,725	572.20	3 41	1 42	1 99
Corn stover,	1,256	954.56	3 13	3 77	64
Corn fodder,	314	59.66	39	14	25
Vetch and oats,	552	138.00	76	47	29
Buckwheat,	1,389	208.35	1 74	1 33	41
Cabbage,	1,200	156.00	1 50	1 34	16
Other green crops,	1,652	330.00	2 07	1 49	58
Turnips and potatoes,	735	90.00	92	40	52
Beets,	615	100.24	1 23	50	73
	-	6,746.45	$50 25	$33 36	$16 89

* The steers consumed approximately the same quantities of food during the entire experiment, only slight difference in coarse fodders being noted.

Steer I.

	Pounds.
Live weight of animal when purchased,	557.00
Live weight of animal when sold,	1,107.00
Total gain during experiment,	550.00
Average gain in weight per day,	1.47
Dry matter required to produce one pound live weight,	12.26

Financial Statement.

	Debit.	Credit.
Original cost of steer,	$20 55	-
Total cost of feed,	50 25	-
Selling price of steer, 1,107 pounds, at 3.85 cents.	-	$42 61
Value of manure produced,	-	33 36
	$70 80	$75 97

	Cents.
Total cost of feed per pound live weight actually produced,	9.14
Net cost of feed per pound live weight actually produced,	3.07
Total cost to us of one pound live beef,	6.39

Steer II.

	Pounds.
Live weight of animal when purchased,	517.00
Live weight of animal when sold,	1,045.00
Total gain during experiment,	528.00
Average gain in weight per day,	1.41
Dry matter required to produce one pound live weight,	12.78

Financial Statement.

	Debit.	Credit.
Original cost of steer,	$19 08	–
Total cost of feed,	50 25	–
Selling price of steer, 1,045 pounds, at 3.85 cents.	–	$40 23
Value of manure produced,	–	33 36
	$69 33	$73 59

	Cents.
Total cost of feed per pound live weight actually produced,	9.52
Net cost of feed per pound live weight actually produced,	3.20
Total cost to us of one pound live beef,	6.63

Steer III.

	Pounds.
Live weight of animal when purchased,	550.00
Live weight of animal when sold,	1,137.00
Total gain during experiment,	587.00
Average gain in weight per day,	1.57
Dry matter required to produce one pound live weight,	11.49

Financial Statement.

	Debit.	Credit.
Original cost of steer,	$20 30	–
Total cost of feed,	50 25	–
Selling price of steer, 1,137 pounds, at 3.85 cents.	–	$43 77
Value of manure produced,	–	33 36
	$70 55	$77 13

	Cents.
Total cost of feed per pound live weight actually produced,	8.57
Net cost of feed per pound live weight actually produced,	2.87
Total cost to us of one pound live beef,	6.20

Summary of Three Steers.

	Pounds.
Live weight of animals when purchased,	1,624.00
Live weight of animals when sold,	3,289.00
Total gain during experiment,	1,665.00
Average gain in weight per day,	1.48
Dry matter required to produce one pound live weight,	12.32

Financial Statement.

	Debit.	Credit.
Original cost of steers,	$59 93	–
Total cost of feed,	150 75	–
Selling price of steers,	–	$126 61
Value of manure produced,	–	100 08
	$210 68	$222 69

	Cents.
Total cost of feed per pound live weight actually produced,	9.08
Net cost of feed per pound live weight actually produced,	3.04
Total cost to us of one pound live beef,	6.41
Net cost to us of one pound live beef,	3.36

The total cost of the 3,289 pounds of live beef actually sold was 6.41 cents per pound, and the net cost, found by deducting the manure reckoned at a maximum value, is 3.36 cents. The steers were sold at 3.85 cents per pound live weight. The animals gained 1.48 pounds live weight daily during the entire experiment. We hardly think it possible to secure better results with the average grade steer. The results, however, make an unfavorable financial showing. (See discussion of results in the general summary of steer-feeding experiments.)

III. SUMMER SOILING *vs.* PASTURE.

This experiment was an exact repetition of the one described in the report for 1893.

The three steers were kept in the barn or turned into the barn-yard during the summer and fall months, and fed upon a variety of green crops raised upon the station grounds in combination with various grains.

Feed consumed by Each Steer during Summer Soiling.

[As the different steers consumed practically the same amount of feed, one statement for the three will suffice.]

FODDER ARTICLES.	Feed Consumed (Pounds).	Local Market Cost.	Manurial Value Obtainable.	Net Cost.
Buffalo gluten feed,	253.50	$2 40	$1 43	$0 97
New-process linseed meal,	367.00	4 95	3 89	1 06
Wheat bran,	205.50	1 95	1 21	74
Soja-bean and corn ensilage,	160.70	2 20	1 27	93
Rowen,	677.00	5 07	2 62	2 45
Vetch and oats (green),	552.00	76	47	29
Other green crops,	1,442.00	1 80	1 30	50
Buckwheat,	1,389.00	1 74	1 33	41
Corn fodder,	814.00	39	14	25
Cabbages,	800.00	1 00	90	10
	-	$22 26	$14 56	$7 70

Summer Soiling compared with Pasture.

	SUMMER SOILING.			PASTURE.		PASTURE.	SOILING.
	Steer I.	Steer II.	Steer III.	Average Two Steers. 1890.	Average Three Steers. 1891.	Average Five Steers.	Average Three Steers.
Date of beginning experiment,	May 1,	May 1,	May 1,	May 10,	April 27,	-	-
Date of ending experiment,	Sept. 30,	Sept. 30,	Sept. 30,	Sept. 30,	Nov. 3,	-	-
Number of days,	153	153	153	144	190	-	-
Live weight of steers at beginning of experiment (pounds),	578	552	630	867	828	-	-
Live weight of steers at end of experiment (pounds),	880	912	835	971	935	-	-
Total weight gained (pounds),	302	360	205	104	107	106	289
Average gain in weight per day (pounds),	1.97	2.35	1.34	0.72	0.57	0.63	1.89
Total cost of feed per day, soiling (cents),	14.55	14.55	14.55	-	-	-	14.55
Net cost of feed per day, soiling (cents),	5.03	5.03	5.03	-	-	-	5.03
Total cost of feed per day at 40 cents per week for pasture (cents),	-	-	-	5.71	3.57*	4.64	-
Total cost of feed required to produce one pound of live weight (cents),	7.38	6.19	10.85	8.24	6.36	7.30	8.14
Net cost of feed required to produce one pound of live weight (cents),	2.55	2.14	3.76	-	-	-	2.82

* Allowing 25 cents per week for pasture.

The results make as good if not a better showing than those reported last year. The comparative merits of soiling *vs.* pasture are briefly discussed in the general summary of steer-feeding experiments.

ADDITIONAL DATA OF THE EXPERIMENT.

Local Market Cost, per Ton, of the Various Articles of Fodder.

Wheat bran,	$19 00
Buffalo gluten feed,	19 00
New-process linseed meal,	27 00
Oat feed,	19 00
Cotton-seed meal,	27 00
Corn and cob meal,	18 00
English hay,	15 00
Vetch and oats (dry),	15 00
Rowen,	15 00
Corn and soja-bean ensilage,	2 75
Turnips,	2 50
Potatoes,	2 50
Mangolds,	4 00
Corn stover,	5 00
Corn ensilage,	2 50
Other green crops,	2 50

Analyses of Fine Feeds.

FODDER ANALYSES.	Wheat Bran.	Buffalo Gluten Feed.	New-process Linseed Meal.	Oat Feed.	Cotton-seed Meal.	Corn and Cob Meal.
Moisture at 100° C.,	11.00	8.00	10.62	7.00	9.00	23.00
Dry matter,	89.00	92.00	89.38	93.00	91.00	77.00
	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.						
Crude ash,	8.00	1.00	5.89	4.61	7.10	1.64
" cellulose,	11.00	7.00	8.84	17.73	5.53	7.54
" fat,	5.00	14.30	3.94	3.95	9.66	4.19
" protein,	18.00	23.60	40.79	11.02	50.34	10.00
Nitrogen free extract,	58.00	54.10	40.54	62.69	27.37	76.63
	100.00	100.00	100.00	100.00	100.00	100.00

Fertilizing Constituents.

[Per Cent.]

[Nitrogen 17½ cents, phosphoric acid 5 cents, potassium oxide 5 cents, per pound.]

FERTILIZER ANALYSES.	Wheat Bran.	Buffalo Gluten Feed.	New-process Linseed Meal.	Oat Feed.	Cotton-seed Meal.	Corn and Cob Meal.
Moisture,	11.00	8.00	10.62	7.00	8.00	23.00
Nitrogen,	2.55	3.47	5.83	1.63	6.88	1.23
Phosphoric acid,	2.46	0.35	1.95	1.25	2.37	0.70
Potassium oxide,	1.58	0.10	1.08	0.80	1.70	0.40
Valuation per 2,000 pounds,	$13 12	$12 14	$23 53	$7 83	$32 24	$5 44
Manurial value obtainable,	11 81	11 34	21 18	7 05	29 00	4 90

Analyses of Coarse Fodder Articles.

[Per Cent.]

FODDER ANALYSES.	Rowen.	Corn and Soja-bean Ensilage.	Corn Ensilage.	Corn Stover.	Turnips.	Potatoes.	Mangolds.
Moisture at 100° C.,	11.30	77.77	79.00	24.00	90.00	78.67	83.71
Dry matter,	88.70	22.23	21.00	76.00*	10.00	21.33	16.29
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.							
Crude ash,	6.48	9.48	4.53	7.14	8.83	4.76	6.79
" cellulose,	30.00	26.63	33.30	33.38	11.75	2.30	5.84
" fat,	4.23	3.75	4.28	1.59	1.68	0.62	0.71
" protein,	12.11	7.91	6.31	9.91	10.37	9.56	13.27
Nitrogen-free extract,	47.18	52.23	51.58	47.98	67.37	82.76	73.39
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* Eighty-three per cent. dry matter during January, February and March.

Fertilizing Constituents.

[Per Cent.]

[Nitrogen 17½ cents, phosphoric acid 5 cents, potassium oxide 5 cents, per pound.]

FERTILIZER ANALYSES.	Rowen.	Corn and Soja-bean Ensilage.	Corn Ensilage.	Corn Stover.	Turnips.	Potatoes.	Mangolds.
Moisture,	11.30	77.77	79.00	20.00	90.00	78.67	83.71
Nitrogen,	1.72	0.32	0.21	1.27	0.16	0.33	0.35
Phosphoric acid,	0.46	0.12	0.03	0.30	0.12	0.13	0.11
Potassium oxide,	1.97	0.48	0.41	1.70	0.38	0.59	0.46
Valuation per 2,000 pounds,	$8 64	$1 77	$1 17	$6 67	$0 96	$1 94	$1 82
Manurial value obtainable,	7 77	1 59	1 05	6 00	86	1 75	1 64

Fertilizing Constituents of "Other Green Crops."

[Per Cent.]

[Nitrogen 17½ cents, phosphoric acid 5 cents, potassium oxide 5 cents, per pound.]

FERTILIZER ANALYSES.	Vetch and Oats.	Buckwheat.	Cabbages.	Corn Fodder.	Other Green Crops.
Moisture,	75.00	85.00	87.00	81.00	80.00
Nitrogen,	0.44	0.44	0.53	0.18	0.43
Phosphoric acid,	0.13	0.09	0.21	0.15	0.15
Potassium oxide,	0.42	0.54	0.39	0.33	0.35
Valuation per 2,000 pounds,	$2 13	$2 15	$2 50	$1 01	$2 00
Manurial value obtainable,	1 70	1 93	2 25	90	1 80

The various leguminous and non-leguminous crops above referred to were fed in small quantities, and it has only been possible to attempt an approximate manurial value.

2. GENERAL SUMMARY OF FEEDING EXPERIMENTS WITH GROWING STEERS.

By J. B. Lindsey.

1890–94.

A series of feeding experiments with growing steers has been carried on at the station since December, 1890, and the details published in the successive annual reports. The last experiment was completed in April, 1894. It seems proper at this time to attempt to present a *general summary* of the results obtained.

The steers experimented with during these four to five years were ten in number, of which seven were grade Shorthorns and three grade Durhams. They were generally bought in the autumn, and weighed about 600 pounds each. These were termed "yearlings." At the beginning of the second winter season they had increased to about 1,000 pounds weight, and were termed "two-year-olds." There was one exception in case of the three steers fed during 1893; these were purchased in the spring of 1893, soiled during the summer and sold in the spring of 1894. Five of the steers were pastured during the summer and five were soiled.

Among the questions to which answers were sought were the following: —

I. What are the most economical fodder rations for beef production?

II. The actual cost of beef production in Massachusetts under existing local conditions.

III. The average daily gain in live weight during an entire experiment.

IV. Dry matter required to produce one pound of live weight.

V. The relative merits and cost of pasture *vs.* soiling during the summer season.

RESULTS OF THE EXPERIMENT.

The Most Economical Rations for Beef Production.

Yearlings.

ARTICLES OF FODDER.	AVERAGE DAILY GAIN IN LIVE WEIGHT (POUNDS).			
	1889-90.	1890-91.	1891-92.	Average.
Grain and corn stover,	1.30*	-	0.75	1.03
Grain and corn ensilage,	2.92	1.40	1.55	1.96
Grain and corn fodder,	1.55*	-	-	1.55
Grain, corn stover and sugar beets,	0.78	-	-	0.78
Grain, hay and roots,	-	1.49	2.04	1.76

* More than the ordinary amount of grain.

Digestible Matter in Above Rations.

ARTICLES OF FODDER.	DIGESTIBLE MATTER CONSUMED DAILY PER 1,000 POUNDS LIVE WEIGHT (POUNDS).				
	Organic Matter.	Protein.	Carbo-hydrates.	Fat.	Nutritive Ratio.
Grain and corn stover,	9.95	1.69	7.81	0.43	1:5.20
Grain and corn ensilage,	13.96	2.56	10.60	0.85	1:5.10
Grain and corn fodder,	13.63	2.47	10.56	0.60	1:4.90
Grain, corn stover and sugar beets,	11.15	2.18	8.54	0.48	1:4.60
Grain, hay and roots,	13.52	2.49	10.42	0.59	1:5.00
Wolff's standard,	15.08	2.17	12.54	0.37	1:6.25

Two-year-olds.

ARTICLES OF FODDER.	AVERAGE DAILY GAIN IN LIVE WEIGHT (POUNDS).					
	1889-90.	1890-91.	1891-92.	1892-93.	1893-94.	Average.
Grain and corn stover,	-	-	-	0.98	0.93	0.95
Grain and corn ensilage,	3.84	1.57	1.44	1.84	1.15	1.97
Grain, hay and straw,	-	1.61	-	-	-	1.61
Grain, hay and roots,	-	1.65	1.15	-	-	1.40

Digestible Matter in Above Rations.

ARTICLES OF FODDER.	DIGESTIBLE MATTER CONSUMED DAILY PER 1,000 POUNDS LIVE WEIGHT (POUNDS).				
	Organic Matter.	Protein.	Carbo-hydrates.	Fat.	Nutritive Ratio.
Grain and corn stover, ...	10.27	1.53	8.36	0.38	1:6.2
Grain and corn ensilage, . . .	11.89	1.94	9.22	0.70	1:5.6
Grain, hay and straw, ...	13.27	2.61	9.93	0.72	1:4.5
Grain, hay and roots, ...	11.94	2.18	9.24	0.51	1:5.0

Summary of Cost of the Average Daily Fodder Rations.

Yearlings.

ARTICLES OF FEED.	Total Cost.	Net Cost.
	Cents.	Cents.
Grain and corn stover, ...	10.06	3.86
Grain, corn stover and sugar beets, . . .	14.98	7.54
Grain and corn ensilage, ...	13.47	5.96
Grain and corn fodder, ...	12.45	4.80
Grain, hay and roots, ...	15.92	8.83

Two-year-olds.

Grain and corn stover, ...	9.98	2.12
Grain and corn ensilage, ...	15.81	6.92
Grain, hay and straw, ...	16.78	6.85
Grain, hay and roots, ...	22.63	12.79

Cost of Feed per Pound of Live Weight gained.

Yearlings.

ARTICLES OF FEED.	Total Cost.	Net Cost.
	Cents.	Cents.
Grain and corn stover, ...	9.77	3.14
Grain, corn stover and sugar beets, . . .	19.20	9.66
Grain and corn ensilage, ...	6.87	2.10
Grain and corn fodder, ...	8.04	3.10
Grain, hay and roots, ...	9.05	5.02

Two-year-olds.

ARTICLES OF FEED.	Total Cost.	Net Cost.
Grain and corn stover, ...	10.50	2.23
Grain and corn ensilage, ...	8.02	3.51
Grain, hay and straw, ...	10.42	4.25
Grain, hay and roots, ...	16.16	9.13

What the Above Tables teach.

(*a*) *Relative Average Gain.*

The chief coarse fodders fed were corn stover, corn fodder, corn ensilage and hay and roots. It is to be observed that in case of both yearlings and two-year-olds the *greatest daily gain* was made when the coarse fodder consisted of corn ensilage. Corn fodder and hay and roots also made a very fair showing. In comparing the table of growth and digestible matter consumed it will be observed that a very close relation exists between them. The more digestible matter consumed, the greater the daily gain. Thus in the case of both yearlings and two-year-olds in 1889–90 the gain in live weight during the ensilage period was exceptionally high.

On referring to the tables published in the annual report for 1892, page 166, it will be seen that the steers consumed a very large amount of food during that time, and to this large food consumption must be attributed the large gain in weight. In case of corn stover as a coarse feed the gain with one exception was small, being about nine-tenths of a pound daily. This is due without doubt to the fact that the total amount of digestible matter consumed during the corn-stover period was relatively small. Corn stover, when fed as a part of the daily coarse fodder ration, makes a valuable food, but when given as a coarse feed exclusively the animals will not consume a quantity sufficient to produce the requisite gain. It has not the sweet taste of the hay, nor the sour, appetizing taste of the ensilage.

On comparing the daily gains with the amount of digestible matter consumed daily, it must be admitted that for an equal amount of digestible matter the corn ensilage rather exceeds all other coarse fodders.

(*b*) *Cost of Daily Gain.*

In comparing the cost of feeds required to produce one pound of live weight, it will be seen that *the relative cost was higher with two-year-olds than with yearlings.* This is in accordance with general teaching.

Again, live weight was produced at the lowest cost both with yearlings and two-year-olds when corn ensilage was the principal coarse fodder of the daily ration. The corn fodder ration is the next higher in cost, and then follow the corn stover and finally, as the highest, the hay ration. When the net cost of feed per pound of live weight gained is considered, the corn-stover period compares very favorably with the ensilage and corn-fodder periods.

In the grain addition to the coarse fodders the point has been to so combine them as to get from 2 to 2.5 pounds of digestible protein in the daily ration.

I. To produce beef, then, at the lowest cost, grow and feed those coarse fodders that yield the largest returns of digestible matter per acre at the least cost of production. Such coarse fodders are corn ensilage, corn fodder and, when properly fed, corn stover.

II. These coarse fodders must be supplemented with concentrated feeds, so as to secure 2 to 2.5 pounds of digestible protein per 1,000 pounds live weight, thus furnishing a ration having a nutritive ratio of 1 : 5 to 1 : 6.

III. In order to secure maximum growth the rations must be palatable as well as properly balanced.

We have no long feeding periods with green crops excepting corn fodder; but our observations teach that vetch and oats is an excellent economical green fodder. Experiments are in progress to ascertain those green crops that are best suited to our conditions and will give a large yield of palatable fodder.

Daily Fodder Rations for Growing Steers.

Yearlings.

I.		II.	
Buffalo gluten feed,	3 qts.	Wheat bran,	4 qts.
Cotton-seed meal,	1½ "	Buffalo gluten feed,	3 "
Corn stover (dry),	8 lbs.	Corn ensilage,	40 lbs.
Hay,	5 "		

III.		IV.	
Chicago gluten meal,	2 qts.	Wheat bran,	4 qts.
Wheat bran,	4 "	New-process linseed meal,	2 "
Corn fodder,	35 lbs.	Green fodder,	40 lbs.

Two-year-olds.

I.		II.	
Buffalo gluten feed,	4 qts.	Wheat bran,	5 qts.
Wheat bran,	5 "	Cotton-seed meal,	2 "
Corn stover,	9 lbs.	Corn ensilage,	50–60 lbs.
Vetch and oats (dry),	7 "		

III.		IV.	
Chicago gluten meal,	3 qts.	Corn meal,	4 qts.
Wheat bran,	5 "	New-process linseed meal,	3 "
Corn fodder,	50–60 lbs.	Green fodder,	60 lbs.

The grain feed in the above rations can be used interchangeably with the coarse fodders. They are so combined as to furnish the necessary amount of protein. One must select the various grains with reference to their cost at the time of feeding them.

The Cost of Beef Production.

In the following table will be found a summary of the financial returns from the ten steers.

It will be remembered that five of the steers were pastured during the summer and five were soiled. The object ever has been to combine the feeds so as to get low-cost rations that would at the same time produce maximum growth.

Financial Statement.

	Debit.	Credit.
Original cost of steers, 6,237 pounds, at 3.55 cents,	$221 27	-
Total cost of feed, ...	596 23	-
Selling price of steers, 11,874 pounds, at 3.88 cents,	-	$460 91
Value of manure produced, ...	-	302 53
	$817 50	$763 44

Total gain in live weight, ...	5,637.00 lbs.
Total cost of feed to produce one pound live weight, . .	10.58 cts.
Net cost of feed to produce one pound live weight, . .	5.56 "
Total cost to us of one pound live beef, ...	6.89 "
Net cost to us of one pound live beef, ...	4.34 "
Average gain in weight per day, ...	1.24 lbs.
Dry matter required to produce one pound live weight,* .	11.32 "

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* For five steers that were soiled.

Remarks on the Above Figures.

It is to be observed that the above results are not at all encouraging. The first cost of the steers plus the feed consumed amounts to more than the returns from the beef plus the value of manure reckoned at a maximum price.

The cost of feed to produce a pound of live weight has been 10.58 cents, while the total cost to us of a pound of live weight (obtained by adding to the original cost of the steers the cost of the feed consumed, and dividing by the pounds of live weight sold) is 6.89 cents. The net cost to us of a pound of live beef reckoned in the same way is 4.34 cents. Only by reckoning the manure at a maximum value have we been able to produce live beef at 4.34 cents per pound, the cost of attendance not being included. It must be remembered, however, that our coarse fodders and grains were charged at market rates.

While the results do not present a favorable financial showing, they teach several lessons. In the first place, the writer thinks it would be policy to begin with calves instead of 600-pound steers. The rate of growth of very young stock is much more rapid, and it would be interesting to see if they could not be grown cheaper than they could be purchased. In the second place, more attention must be given to the kind of steer grown. We must have steers that will grow more rapidly than those experimented with. Just as there are good and poor milch cows, so there are good and poor growing steers. Feed, it must be remembered, is only secondary. We must first have the cow bred with a capacity for milk production, and then help her to produce maximum yields by properly feeding her; and in just the same way we must have the steer so bred as to grow rapidly, then, by judicious and economical feeding, seek to get the greatest growth at the minimum cost for feed. The writer believes that by beginning with young calves from animals that have extra reputation for rapid growth, and following a judicious system of feeding, it will yet be possible to produce beef economically in Massachusetts.

Summer Soiling vs. Pasture.

	SUMMER SOILING.		PASTURE.		AVERAGE SOILING.	AVERAGE PASTURE.
	Average Two Steers. 1892.	Average Three Steers. 1893.	Average Two Steers. 1890.	Average Three Steers. 1891.	Average Five Steers.	Average Five Steers.
Date of beginning experiment,	May 1,	May 1,	May 10,	April 27,	-	-
Date of ending experiment,	Sept. 30,	Sept. 30,	Sept. 30,	Nov. 3,	-	-
Number of days,	153	153	144	190	-	-
Live weight of steers at beginning of experiment (pounds),	822	587	867	828	704	847
Live weight of steers at end of experiment (pounds),	1,027	876	971	935	951	953
Total weight gained (pounds),	205	289	104	107	247	106
Average gain in weight per day (pounds),	1.37	1.89	0.72	0.57	1.63	0.63
Total cost of feed per day, soiling (cents),	12.72	14.56	-	-	13.63	-
Net cost of feed per day, soiling (cents),	6.18	5.03	-	-	5.61	-
Total cost of feed per day at forty cents per week for pasture (cents),	-	-	5.71	3.57*	-	4.64
Total cost of feed required to produce one pound live weight (cents),	9.37	8.14	8.24	6.36	8.75	7.30
Net cost of feed required to produce one pound live weight (cents),	4.55	2.82	-	-	3.68	-

* Allowing twenty-five cents per week for pasture.

It will be seen from the above table that the animals soiled made fully two and one-half times the daily gain as did the pasture lots. This is probably due to an abundance of food on the part of the soiled steers. The pastures were what were termed "good" by the average farmer.

The total cost of feed to produce a pound of live weight is about the same in each case. In case of the soiled animals, however, the manure is left upon the farm. If one might assume that the value of the manure from a commercial standpoint would about pay for cost of attendance, the conditions would appear to be about equal. It must not be forgotten, however, that all of the coarse fodders grown upon the place were charged at market rates.

The writer thinks, judging from the above results, that no absolute rule can be laid down to govern all cases. Local conditions and circumstances would undoubtedly be the determining factors. Other things being equal, steers can at least be as economically grown by soiling as by pasturing.

VII.

FEEDING CALVES FOR VEAL.

By J. B. Lindsey.

In our annual report for 1893 was presented an experiment in feeding very young calves with skim-milk alone and with skim-milk combined with various grains. The calves were sold for veal when from seven to ten weeks old. The object was to inquire into the price that could be obtained for the skim-milk per quart when fed to calves and pigs. The results were as follows: —

Calves. — Summary of Results.

1. Price returned per quart for skim-milk, when live weight sells at 4½ cents per pound: —

	Cents.
Calves 1, 2, 3 and 4 (grain and skim-milk),	0.77
Calves 5, 6 and 7 (skim-milk alone),	0.75
Average of seven calves,	0.76

2. Price returned per quart for skim-milk, when live weight sells at 4 cents per pound: —

	Cents.
Calves 1, 2, 3 and 4 (grain and skim-milk),	0.64
Calves 5, 6 and 7 (skim-milk alone),	0.63
Average of seven calves,	0.63

Price obtained for Skim-milk per Quart when fed to Pigs.

Here follow the average results obtained from experiments with forty pigs, being six distinct lots, fed during the years 1890–91 and 1892–93. In this number grade Chester Whites predominated, but several Yorkshires, Berkshires, Poland Chinas and Tamworths are also included.

Statement.

[Cents.]

Dressed Pork sold at—	5½ Cents.	6 Cents.	6½ Cents.	7 Cents.	7½ Cents.	8 Cents.
Price returned per quart for skim-milk fed, . . .	0.21	0.30	0.46	0.58	0.70	0.81

COMMENTS ON CALF-FEEDING EXPERIMENT (1893).

The experiment has shown that calves grown upon skim-milk alone or upon skim-milk and grains during the first eight weeks of their lives make good gains in live weight, namely, from 0.9 to 2.13 pounds per day, with an average of 1.49 pounds. These animals, however, put on very little fat, either when fed on skim-milk alone or when fed on skim-milk and grains. They were not able to digest the necessary amount of corn meal, Buffalo gluten feed, wheat flour or middlings, when fed in connection with the nitrogenous milk, to promote the formation of fat.

The meat of the animals thus described was quite white in appearance, but not as tender as calves that were fed whole milk. The ribs and flanks of animals thus fed were thinner than those consuming whole milk, and the shrinkage in dressing was from 5 to 7 per cent. more.

OBJECTS OF THE PRESENT EXPERIMENT (1894).

I. To see if it were possible to replace the butter fat removed in the cream by some cheaper fat or oil, thus producing a mixture resembling in composition whole milk.

II. To see if this mixture would fatten calves economically.

RESULTS OF THE EXPERIMENT.

I. By feeding, in addition to skim-milk, oleomargarine, cotton-seed oil, corn oil and brown sugar, calves were grown to weigh 160 pounds when seven weeks old. These calves were fairly fat, showing a better condition than calves fed on skim-milk entirely, but were not equal to sucking calves.

II. The experiment was not a financial success, however, the increased price obtained for the calves being more than counterbalanced by the cost of the fats and the extra labor in preparing the food.

III. In one case (calf 7), where oleomargarine and brown sugar were fed in addition to the skim-milk, the result was decidedly encouraging. The calf was in good condition, and returned 0.91 of a cent per quart for the skim-milk fed.

THE EXPERIMENT EXPLAINED.

How the Artificial Milk was prepared.

The object was, if possible, to make an emulsion of the fat or oil with the skim-milk. For this purpose a tin vessel, very much resembling the ordinary creamery can, was made. It was twenty-two inches deep and six inches in diameter. There was a "dasher," which consisted simply of a rod about eight inches longer than the depth of the can, made of tin (or wood), to one end of which was fastened a perforated tin disk. The disk was of such a diameter that it could be worked up and down easily in the can, which was provided with a cover with a hole in the centre, through which the rod protruded. A cheap grade of oleomargarine was first used. It was added to the skim-milk and the latter heated to 110° F. This melted the "oleo," and the solution was then transferred to the tin churn and worked for several minutes. By this method the oil was quite well mixed with the milk, and the resulting solution had a very pleasant smell, closely resembling that of new milk. It was fed in a Small's calf-feeder, and the calves drank it readily. The artificial milk had practically the following composition, as compared with ordinary pure milk: —

	Artificial Milk (Per Cent.).	Pure Milk (Per Cent.).
Water, ...	86.60	87.00
Total solids, ...	13.40	13.00
Fat, ...	3.78	4.00

The above analysis of artificial milk represents one ounce of "oleo" to each quart of skim-milk. Scarcely any of the calves appeared to be able to take more than this amount per quart without disturbing their digestion. When one and a half ounces per quart were fed indigestion nearly always resulted, and the manure voided contained an excessive amount of fat, fatty acids and similar substances. During the last few weeks of the calf's life one and a quarter ounces were fed for each quart of the skim-milk.

Other Oils substituted.

Only one-half ounce of either cotton-seed or corn oil could be fed per quart of milk without producing bad effects. One calf was fed with one-half ounce of "oleo" and one-half ounce of cotton-seed oil per quart of milk. Another was fed with one-half ounce of "oleo" and two ounces of brown sugar per quart of skim-milk.

Following comes the financial record of the seven calves. Five were fed skim-milk and "oleo," one skim-milk and cotton-seed and corn oils, and one skim-milk, "oleo" and brown sugar.

Financial Results.

Calf 1.

Age when received: three days.

Breed: Jersey, bull.

Foods fed: whole milk for the first four days, and then gradually changing to skim-milk mixed with oleomargarine.

Financial Statement.

	Debit.	Credit.
Original cost,	$1 00	–
23.00 quarts whole milk, at 3 cents,	69	–
23.83 pounds "oleo," at 10½ cents,	2 50	–
134.00 pounds live weight, at 5 cents,	–	$6 70
332.00 quarts skim-milk returned,	2 51	–
	$6 70	$6 70

Price returned per quart for skim-milk fed, ... 0.76 cents.

Calf 2.

Age when received: two days.
Breed: Jersey, bull.
Foods fed: same as No. 1.

Financial Statement.

	Debit.	Credit.
Original cost, ...	$1 00	-
45.00 quarts whole milk, at 3 cents, . . .	1 35	-
34.70 pounds "oleo," at 10½ cents, . . .	3 64	-
91.00 pounds dressed weight, at 7 cents, . .	-	$6 37
446.00 quarts skim-milk returned, . . .	38	-
	$6 37	$6 37

Price returned per quart for skim-milk fed, . . . 0.08 of a cent.

Calf 3.

Age when received: three days.
Breed: grade Durham, bull.
Foods fed: same as No. 1.

Financial Statement.

	Debit.	Credit.
Original cost, ...	$1 00	-
75.50 quarts whole milk, at 3 cents, . . .	2 27	-
36.33 pounds "oleo," at 10½ cents, . . .	3 81	-
86.00 pounds dressed weight, at 7½ cents, .	-	$6 45
521.00 quarts skim-milk returned, . . .	-	—0 63
	$7 08	$7 08

Calf 4.

Age when received: three days.
Breed: grade Ayrshire, heifer.
Foods fed: same as No. 1.

Financial Statement.

	Debit.	Credit.
Original cost, ...	$1 00	-
75.50 quarts whole milk, at 3 cents, ...	2 27	-
33.24 pounds "oleo," at 10½ cents, ...	3 49	-
86.50 pounds dressed weight, at 7½ cents, .	-	$6 48
474.00 quarts skim-milk returned, ...	-	—0 28
	$6 76	$6 76

Calf 5.

Age when received: seven days.
Breed: grade Holstein, bull.

Foods fed: whole milk first five days, and then gradually changed to skim-milk mixed with oleomargarine, cotton-seed and corn oils.

Financial Statement.

	Debit.	Credit.
Original cost, ...	$1 00	-
50.00 quarts whole milk, at 3 cents, ...	1 50	-
5.38 pounds "oleo," at 10½ cents, ...	56	-
224.00 ounces cotton-seed oil, at 8 cents, . .	1 79	-
42.00 ounces corn oil, at 8 cents, ...	34	-
152.00 pounds live weight, at 4 cents, . . .	-	$6 08
442.50 quarts skim-milk returned, ...	89	-
	$6 08	$6 08

Price returned per quart for skim-milk fed, ... 0.20 of a cent.

Calf 6.

Age when received: ten days.

Breed: grade Holstein, bull.

Foods fed: same as No. 1.

Financial Statement.

	Debit.	Credit.
Original cost,	$1 00	-
50.00 quarts whole milk, at 3 cents,	1 50	-
25.81 pounds "oleo," at 10½ cents,	2 71	-
73.00 pounds dressed weight, at 8 cents,	-	$5 84
303.00 quarts skim-milk returned,	63	-
	$5 84	$5 84

Price returned per quart for skim-milk fed, ... 0.21 of a cent.

Calf 7.

Age when received: three days.

Breed: grade Durham, bull.

Foods fed: whole milk for first five days, then skim-milk mixed with different amounts of tallow, oleomargarine and brown sugar.

Financial Statement.

	Debit.	Credit.
Original cost,	$1 00	-
42.00 quarts whole milk, at 3 cents,	1 26	-
6.69 pounds jacket tallow, at 6 cents,*	40	-
8.50 pounds "oleo," at 10½ cents,	89	-
8.06 pounds sugar, at 4 cents,	32	-
153.50 pounds live weight, at 4½ cents,	-	$6 91
334.00 quarts skim-milk returned,	3 04	-
	$6 91	$6 91

Price returned per quart for skim-milk fed, ... 0.91 of a cent.

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* Jacket tallow was not satisfactory; it crystallized out rapidly from the emulsion, and was consequently only partially consumed.

GENERAL CONCLUSIONS.

	1893.	1894.
Average daily gain in live weight (pounds), . .	1.49	1.55
Dry matter required to produce one pound live weight (pounds), ...	1.77	1.67
Dry matter required to produce one pound dressed weight (pounds), ...	2.98	3.09
Shrinkage in dressing (per cent., ...	44.22	44.57
Average number of weeks fed, ...	10	7
Average weight of calves when sold (pounds), .	177	150

The financial results of the experiment are not satisfactory. The average return for the skim-milk in case of the seven calves was but 0.28 of a cent per quart. Last year, when skim-milk alone was fed, a return of from 0.63 to 0.73 of a cent per quart was secured. Although the condition of these calves was superior to those grown on skim-milk alone, our local butcher refused to give much if any more, simply because they were not "suckers." Whole-milk veal being worth six cents, live weight, these calves were certainly worth five cents, while from nearly all of them but from four to four and a half cents could be obtained. If five cents per pound live weight had been obtained the financial showing would have been better, but even then not satisfactory. The condition of the calves fed on artificial milk was, as above mentioned, much more satisfactory than those fed on the skim-milk. They were not, however, equal in fatness to sucking calves.

Calf 1 was in a very fair condition. The kidneys were quite well covered with fat. Calves 3 and 4 were equal to No. 1. Calf 5 was fed partly on cotton-seed oil as a source of fat. When the oil was first fed the calf seemed to improve in condition, and his coat took on a glossy appearance; but continued feeding of the oil did not appear to be favorable, and when slaughtered his carcass contained very little fat. Calf 7, fed on skim-milk with one part "oleo" to two parts brown sugar as cream substitute, gave by far the best results. He grew rapidly, making an average daily gain of 2.04 pounds, and he returned 0.91 of a cent per quart for the skim-milk fed. His kidneys were quite well covered with fat.

It is intended to note the effect of this mixture on other calves. It must be admitted that considerable labor is required to feed calves as described, and when pork brings from six and a half to seven cents per pound dressed weight it will undoubtedly be more profitable to feed the skim-milk to pigs. The average farmer would not find it profitable to attempt to fatten veal calves by this method.

If the mixture of skim-milk, "oleo" and brown sugar or skim-milk and brown sugar gives approximately as good results with the average calf as it did in case of calf 7 of the present experiment, fatting veal by this process might prove profitable to a limited number when circumstances were favorable.

When pork is below six and a half cents per pound, dressed weight, it would undoubtedly be profitable to feed the skim-milk alone to calves after they are a week old, provided they will bring four cents per pound live weight. When eight to nine weeks old they will weigh about 160 pounds.

Skim-milk can also be fed with decided profit to calves that are intended to be raised to maturity upon the farm. As soon as the animals are old enough to consume grain in addition to the milk, equal parts of Buffalo gluten feed and corn meal or cream gluten meal and corn meal can be fed dry.

TABLES SHOWING AVERAGE DAILY FOOD CONSUMPTION AND GAIN IN LIVE WEIGHT.

Calf 1.

WEEKLY PERIODS (DATES).	Weight of Animal (Pounds).	AVERAGE DAILY AMOUNT OF FEED CONSUMED.		
		Whole Milk (Quarts).	Skim-milk (Quarts).	"Oleo" (Pounds).
May 5–7, ...	66.75	4.33	0.33	0.02
14, ...	78.50	1.43	5.43	0.36
21, ...	87.00	–	7.43	0.47
28, ...	99.00	–	9.00	0.50
June 4, ...	114.00	–	10.43	0.68
11, ...	130.25	–	11.57	0.97
13, ...	134.00	–	12.00	1.05
Average daily gain, . .	1.68	–	–	–

Calf 2.

May 5–7, ...	68.75	4.33	–	–
14, ...	74.50	3.43	1.29	0.11
21, ...	87.00	1.14	5.86	0.40
28, ...	97.50	–	8.86	0.50
June 4, ...	115.00	–	10.43	0.68
11, ...	130.25	–	11.57	0.97
18, ...	144.00	–	12.00	1.05
25, ...	157.00	–	12.00	1.05
26, ...	156.00	–	12.00	1.05
Average daily gain, . .	1.65	–	–	–

Calf 3.

WEEKLY PERIODS (DATES).	Weight of Animal (Pounds).	AVERAGE DAILY AMOUNT OF FEED CONSUMED.		
		Whole Milk (Quarts).	Skim-milk (Quarts).	"Oleo" (Pounds).
June 13,	60.50	6.00	-	-
18,	70.00	6.00	-	-
25,	79.50	2.57	3.43	0.22
July 2,	80.00	0.29	5.86	0.38
9,	92.00	-	8.14	0.53
16,	105.00	-	9.57	0.63
23,	119.50	-	10.14	0.66
30,	137.50	-	11.14	0.73
Aug. 6,	146.50	2.79	9.43	0.31
15,	153.00	-	13.00	0.99
Average daily gain,	1.45	-	-	-

Calf 4.

June 18,	75.00	4.00	-	-
25,	75.00	4.71	-	-
July 2,	82.25	3.29	2.29	0.15
9,	94.00	-	8.43	0.56
16,	105.00	-	9.57	0.63
23,	121.25	-	10.14	0.66
30,	136.50	-	11.14	0.73
Aug. 6,	142.50	2.79	9.43	0.31
13,	157.75	-	13.00	0.99
15,	156.00	-	13.00	0.99
Average daily gain,	1.37	-	-	-

Calf 5.

WEEKLY PERIODS (DATES).	Weight of Animal (Pounds).	AVERAGE DAILY AMOUNT OF FEED CONSUMED.				
		Whole Milk (Quarts).	Skim-milk (Quarts).	"Oleo" (Pounds).	Cotton-seed Oil (Ounces).	Corn Oil (Ounces).
Aug. 14, . .	71.00	3.00	-	-	-	-
22, . .	83.50	5.13	0.75	0.05	-	-
28, . .	94.25	1.00	6.00	0.38	-	-
Sept. 4, . .	102.00	-	8.14	0.29	3.57	-
10, .	118.00	-	9.00	0.13	7.00	-
18, . .	123.50	-	9.25	-	5.63	-
24, . .	130.50	-	9.75	-	7.17	0.50
Oct. 1, . .	137.50	-	9.00	-	3.86	3.00
8, . .	148.50	-	8.57	-	3.43	2.57
11, . .	152.00	-	12.00	-	6.00	-
Av. daily gain,	1.37	-	-	-	-	-

Calf 6.

WEEKLY PERIODS (DATES).	Weight of Animal (Pounds).	AVERAGE DAILY AMOUNT OF FEED CONSUMED.		
		Whole Milk (Quarts).	Skim-milk (Quarts).	"Oleo" (Pounds).
Aug. 14, ...	87.00	3.00	-	-
22, ...	98.50	5.13	0.75	0.05
28, ...	109.00	1.00	6.00	0.38
Sept. 4, ...	115.00	-	8.14	0.73
10, ...	122.50	-	9.00	0.84
17, ...	131.50	-	9.57	0.90
24, ...	138.50	-	9.86	0.88
26, ...	144.00	-	11.00	0.69
Average daily gain, .	1.30	-	-	-

Calf 7.

WEEKLY PERIODS (DATES).	Weight of Animal (Pounds).	AVERAGE DAILY AMOUNT OF FEED CONSUMED.				
		Whole Milk (Quarts).	Skim-milk (Quarts).	Jacket Tallow (Pounds).	"Oleo" (Pounds).	Sugar (Pounds).
Sept. 4, . .	70.00	-	-	-	-	-
10, . .	77.00	5.00	-	-	-	-
17, . .	87.00	1.71	4.57	0.29	-	-
24, . .	98.00	-	8.14	0.51	-	-
Oct. 1, . .	118.00	-	9.86	0.16	0.41	0.05
8, . .	137.50	-	11.14	-	0.38	0.47
15, . .	153.50	-	12.14	-	0.38	0.59
Av. daily gain,	2.04	-	-	-	-	-

TABLES GIVING DETAILED RECORD OF EACH CALF.

Calf 1.

Feeding Periods.	DATE OF PERIODS.	Whole Milk (Quarts).	Skim-milk (Quarts).	"Oleo" (Pounds).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain (Pounds).	Cost of Feed per Pound of Live Weight gained (Cents).
I.	May 5 to May 28,	23.00	154.00	10.00	1:4	66.75	99.00	1.34	7.53
II.	May 29 to June 13,	-	178.00	13.83	1:4.4	99.00	134.00	2.20	6.43

Total Amount of Feed consumed from May 5 to June 13, 1894.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
23.00 quarts whole milk, ...	6.83	$0 69	$0 04
332.00 quarts skim-milk, ...	69.34	1 49	49
23.83 pounds "oleo,"	23.83	2 50	-
	100.00	$4 68	$0 53

Live weight of the animal at the beginning of the experiment,	66.75 lbs.
Live weight of the animal at the end of the experiment, .	134.00 "
Live weight gained during the experiment, ...	67.25 "
Dressed weight of the animal, ...	74.00 "
Loss in weight by dressing, 44.78 per cent., ...	60.00 "
Pounds of dry matter to produce 1 pound of live weight, .	1.29 "
Pounds of dry matter to produce 1 pound of dressed weight,	2.69 "
Total cost of feed per pound of live weight gained, . .	6.95 cts.
Net cost of feed per pound of live weight gained, . .	6.17 "

Calf 2.

Feeding Periods.	DATE OF PERIODS.	Whole Milk (Quarts).	Skim-milk (Quarts).	"Oleo" (Pounds).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain (Pounds).	Cost of Feed per Pound of Live Weight gained (Cents).
I.	May 5 to May 28,	45.00	112.00	7.50	1:4.25	68.75	97.50	1.20	9.19
II.	May 29 to June 11,	-	154.00	11.60	1:4.2	97.50	130.25	2.34	5.84
III.	June 12 to June 26,	-	180.00	15.60	1:4.6	130.25	156.00	1.72	9.51

Total Amount of Feed consumed from May 5 to June 26, 1894.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
45.00 quarts whole milk,	13.37	$1 35	$0 07
446.00 quarts skim-milk,	93.14	2 01	66
34.70 pounds "oleo,"	34.70	3 64	-
	141.21	$7 00	$0 73

Live weight of the animal at the beginning of the experiment,	**68.75 lbs.**
Live weight of the animal at the end of the experiment,	**156.00 "**
Live weight gained during the experiment,	**87.25 "**
Dressed weight of the animal,	**91.00 "**
Loss in weight by dressing, 41.67 per cent.,	**65.00 "**
Pounds ot dry matter to produce 1 pound of live weight,	**1.62 "**
Pounds of dry matter to produce 1 pound of dressed weight,	**2.77 "**
Total cost of feed per pound of live weight gained,	**8.02 cts.**
Net cost of feed per pound of live weight gained,	**7.19 "**

Calf 3.

Feeding Periods.	Date of Periods.	Whole Milk (Quarts).	Skim-milk (Quarts).	" Oleo " (Pounds).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain (Pounds).	Cost of Feed per Pound of Live Weight gained (Cents).
I.	June 13 to July 9,	56.00	122.00	8.01	1:4.2	60.50	92.00	1.17	9.75
II.	July 10 to July 23,	-	138.00	9.06	1:4.1	92.00	119.50	1.96	5.72
III.	July 24 to Aug. 15,	19.50	261.00	19.26	1:4.3	119.50	153.00	1.46	11.29

Total Amount of Feed consumed from June 13 to Aug. 15, 1894.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
75.50 quarts whole milk, ...	22.43	$2 27	$0 12
521.00 quarts skim-milk, ...	109.77	2 34	77
36.33 pounds " oleo,"	36.33	3 81	-
	168.53	$8 42	$0 89

Live weight of the animal at the beginning of the experiment,	60.50 lbs.
Live weight of the animal at the end of the experiment, .	153.00 "
Live weight gained during the experiment, ...	92.50 "
Dressed weight of the animal, ...	86.00 "
Loss in weight by dressing, 43.79 per cent., ...	67.00 "
Pounds of dry matter to produce 1 pound of live weight, .	1.82 "
Pounds of dry matter to produce 1 pound of dressed weight,	3.24 "
Total cost of feed per pound of live weight gained, . . .	9.10 cts.
Net cost of feed per pound of live weight gained, . . .	8.14 "

Calf 4.

Feeding Periods.	Date of Periods.	Whole Milk (Quarts).	Skim-milk (Quarts).	"Oleo" (Pounds).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain (Pounds).	Cost of Feed per Pound of Live Weight gained (Cents).
I.	June 18 to July 16,	56.00	142.00	9.32	1:4.2	75.00	105.00	1.03	10.99
II.	July 17 to July 30,	-	149.00	9.78	1:4.1	105.00	136.50	2.25	5.39
III.	July 31 to Aug. 15,	19.50	183.00	14.14	1:4.4	136.50	156.00	1.22	14.82

Total Amount of Feed consumed from June 18 to Aug. 15, 1894.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
75.50 quarts whole milk, ...	22.43	$2 27	$0 12
474.00 quarts skim-milk, ...	98.99	2 13	70
33.24 pounds "oleo,"	33.24	3 49	-
	154.66	$7 89	$0 82

Live weight of the animal at the beginning of the experiment,	75.00 lbs.
Live weight of the animal at the end of the experiment, .	156.00 "
Live weight gained during the experiment, . . .	81.00 "
Dressed weight of the animal, ...	86.50 "
Loss in weight by dressing, 44.55 per cent., . . .	69.50 "
Pounds of dry matter to produce 1 pound of live weight, .	1.91 "
Pounds of dry matter to produce 1 pound of dressed weight,	3.44 "
Total cost of feed per pound of live weight gained, . .	9.74 cts.
Net cost of feed per pound of live weight gained, . .	8.73 "

Calf 5.

Feeding Periods.	Date of Periods.	Whole Milk (Quarts).	Skim-milk (Quarts).	"Oleo" (Pounds).	Cotton-seed Oil (Pounds).	Corn Oil Pounds).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain (Pounds).	Cost of Feed per Pound of Live Weight gained (Cents).
I.	Aug. 14 to Sept. 4,	50.00	99.00	4.63	1.56	-	1:4	71.00	102.00	1.41	8.49
II.	Sept. 5 to Sept. 18,	-	128.00	0.75	5.44	-		102.00	123.50	1.54	6.28
III.	Sept. 19 to Oct. 11,	-	215.50	-	7.00	2.62		123.50	152.00	1.24	7.72

Total Amount of Feed consumed from Aug. 14 to Oct. 11, 1894

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
50.00 quarts whole milk, ...	14.86	$1 50	$0 08
442.50 quarts skim-milk, ...	92.41	1 99	65
5.38 pounds "oleo,"	5.38	56	-
224.00 ounces cotton-seed oil, . . .	14.00	1 79	-
42.00 ounces corn oil, ...	2.63	34	-
	129.28	$6 18	$0 73

Live weight of the animal at the beginning of the experiment,	71.00 lbs.
Live weight of the animal at the end of the experiment, .	152.00 "
Live weight gained during the experiment, ...	81.00 "
Dressed weight of the animal, ...	-
Loss in weight by dressing, per cent., ...	-
Pounds of dry matter to produce 1 pound of live weight, .	1.60 "
Pounds of dry matter to produce 1 pound of dressed weight,	-
Total cost of feed per pound of live weight gained, . .	7.63 cts.
Net cost of feed per pound of live weight gained, . .	6.73 "

Calf 6.

Feeding Periods.	Date of Periods.	Whole Milk (Quarts).	Skim-milk (Quarts).	Cotton-seed Oil (Pounds).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain (Pounds).	Cost of Feed per Pound of Live Weight gained (Cents).
I.	Aug. 14 to Aug. 22,	44.00	6.00	0.37	1:4 to 1:4.5	87.00	98.50	1.28	12.04
II.	Aug. 23 to Sept. 10,	6.00	147.00	12.41		98.50	122.50	1.26	8.93
III.	Sept. 11 to Sept. 26,	-	150.00	13.03		122.50	144.00	1.34	9.50

Total Amount of Feed consumed from Aug. 14 to Sept. 26, 1894.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
50.00 quarts whole milk, ...	14.86	$1 50	$0 08
303.00 quarts skim-milk, ...	63.28	1 36	45
25.81 pounds "oleo,"	25.81	2 71	-
	103.95	$5 57	$0 53

Live weight of the animal at the beginning of the experiment,	87.00 lbs.
Live weight of the animal at the end of the experiment, .	144.00 "
Live weight gained during the experiment, . . .	57.00 "
Dressed weight of the animal, ...	73.00 "
Loss in weight by dressing, 49.31 per cent., . . .	71.00 "
Pounds of dry matter to produce 1 pound of live weight,	1.82 "
Pounds of dry matter to produce 1 pound of dressed weight,	3.51 "
Total cost of feed per pound of live weight gained, . .	9.77 cts.
Net cost of feed per pound of live weight gained, . .	8.84 "

Calf 7.

Feeding Periods.	Date of Periods.	Whole Milk (Quarts).	Skim-milk (Quarts).	Jacket Tallow (Pounds).	"Oleo" (Pounds).	Sugar (Pounds).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain (Pounds).	Cost of Feed per Pound of Live Weight gained (Cents).
I.	Sept. 4 to Sept. 24,	42.00	89.00	5.56	-	-	1:3.5 to 1:4	70.00	98.00	1.33	7.12
II.	Sept. 25 to Oct. 1,	-	69.00	1.13	2.88	0.37		98.00	118.00	2.86	3.48
III.	Oct. 2 to Oct. 16,	-	176.00	-	5.62	7.69		118.00	153.50	2.33	4.70

Total Amount of Feed consumed from Sept. 4 to Oct. 16, 1894.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
42.00 quarts whole milk,	12.47	$1 26	$0 06
334.00 quarts skim-milk,	69.75	1 50	49
6.69 pounds jacket tallow,	6.69	40	-
8.50 pounds "oleo,"	8.50	89	-
8.06 pounds sugar,	8.06	32	-
	105.47	$4 37	$0 53

Live weight of the animal at the beginning of the experiment,	70.00 lbs.
Live weight of the animal at the end of the experiment,	153.50 "
Live weight gained during the experiment,	63.50 "
Dressed weight of the animal,	87.00 "
Loss in weight by dressing, 43.32 per cent.,	66.50 "
Pounds of dry matter to produce 1 pound of live weight,	1.66 "
Pounds of dry matter to produce 1 pound of dressed weight,	2.93 "
Total cost of feed per pound of live weight gained,	6.88 cts.
Net cost of feed per pound of live weight gained,	6.05 "

Average Analyses of Milks.

FODDER ANALYSES	Skim-milk.	Whole Milk.
Moisture at 100° C.,	90.42	86.18
Dry matter,	9.58	13.82
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	8.14	5.35
" cellulose,	–	-
" fat,	2.61	33.43
" protein,	35.23	25.33
Non-nitrogenous extract matter,	54.02	35.89
	100.00	100.00

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5 cents, potassium oxide 5 cents, per pound.]

FERTILIZER ANALYSES.	Skim-milk.	Whole Milk.
Moisture,	90.42	86.18
Nitrogen,	0.52	0.56
Phosphoric acid,	0.18	0.19
Potassium oxide,	0.19	0.17
Value per 2,000 pounds,	$1 93	$2 04
Manurial value obtainable,*	1 35	1 43

* Allowing thirty per cent. of the fertilizing constituents to be retained in the system of the growing animal.

Local Market Value of the Various Foods.

Whole milk (per gallon),	12.0 cts.
Skim-milk (per gallon),	1.8 "
Cotton-seed oil (per gallon),	$1 00
Corn oil (per gallon),	1 00
Oleomargarine (per pound),	10.5 cts.
Jacket tallow (per pound),	5.5 "
Brown sugar (per pound),	4.0 "

VIII.

DIGESTION EXPERIMENTS.

1. DIGESTION EXPERIMENTS WITH SHEEP.

BY J. B. LINDSEY, R. H. SMITH AND E. B. HOLLAND.

During the past year we have continued the study of the digestibility of the concentrated by-products so freely offered for sale in our eastern markets. Especial attention has been given to the gluten feeds and meals. The results obtained with the gluten feeds are not as yet decisive. The coefficients of digestibility, in case of different samples of these feeds, appear to vary considerably. Whether this is caused by the method of preparation is not as yet clear. Additional tests will be made.

VALUE OF DIGESTION EXPERIMENTS.

1. A food is valuable as a source of nourishment only in so far as its various constituents can be digested and assimilated. Two kinds of hay, one early and the other late cut, might be consumed in equal quantities by an animal, yet the early cut hay, having more digestible matter, would prove the more valuable fodder.

For one to form an intelligent opinion as to the value of different fodder stuffs, the amount of digestible matter they contain must be known.

2. In order to combine the different fodder stuffs so as to obtain properly balanced rations for our farm stock, one should know the percentages of the different digestible constituents contained in each of the several foods.

THE EXCRETA OF AN ANIMAL, — WHAT THEY ARE.

The fæces are nothing more than the undigested portions of the food. They are the portions that have resisted the action of the various secretions of the stomach and digestive fluids and bacteria of the intestines, and are consequently excreted by the animal as so much worthless material. The urine is entirely distinct from the fæces. It contains the water and the end products of the digestion of the nitrogenous portion of the food, — the urea and hippuric acid, — which have been removed from the blood by the kidneys. It also contains about one-third of the phosphoric acid and nearly all of the alkalies of the food consumed that have not been retained in the animal's system, and small quantities of other materials that it is unnecessary to consider in this connection.

HOW THE DIGESTIBLE MATTER OF A FOOD IS DETERMINED.

First ascertain the amount and composition of the food consumed by an animal in a given length of time, also the amount and composition of the fæces or undigested portion excreted in the same time on the basis of dry matter. The difference between them will represent the amount of the various constituents of the food digested.

The percentages of the constituents digested are called the digestion coefficients.

A Single Illustration, showing how the Digestibility of a Fodder is determined.

[Solid manure equals the undigested part of food.]

English Hay.

	Dry Matter (Grams).	Crude Cellulose (Grams).	Crude Fat (Grams).	Crude Protein (Grams).	Extract Matter (Grams).
900 grams hay fed, equal to . . .	765.36	250.58	23.57	82.58	348.69
369.3 grams manure excreted, equal to	337.95	107.00	12.81	34.64	145.89
Amount of hay digested, . .	427.41	143.58	10.76	47.94	202.80
Per cent. digested, ...	55.84	57.30	45.65	58.05	58.16

METHODS EMPLOYED.

Four sheep were used. Nos. 1 and 2 were four years old, and Nos. 3 and 4 two years. The full details of the method will be found fully described in the eleventh report of this station, 1893.

FEEDS TESTED.

Hay of Mixed Grasses.

The hay is a fair average of that grown upon the station grounds. It was harvested the latter part of June, when the various grasses were in blossom. The grasses of which it was composed were principally herds grass, red top, Kentucky blue grass, meadow fescue, sweet-scented vernal grass, together with a fair sprinkling of clover. It was fed alone, and as a coarse fodder in combination with the different grains tested.

Vetch and Oats.

The vetch and oats are fed by us as a substitute for hay. They were sown at the rate of 4 bushels of oats and 40 pounds of vetch per acre about the middle of April. These were cut in late blossom, and made into hay. If cut in early bloom they would probably prove somewhat more digestible.

New-process Linseed Meal.

Linseed meal is the flaxseed remaining after the oil has been removed. In case of the new-process meal the oil is extracted by naphtha or some similar solvent, and is in consequence more thoroughly removed than by pressure.

Buffalo Gluten Feed.

This is a by-product in the manufacture of starch from corn. The starch is separated from the yellow or albuminous part of the grain by means of water. The hulls and germs are separated by screening. After the starch is removed the yellow or flinty portion is mixed with the germs and hulls. The mixture is kiln-dried and partially ground.

Peoria Gluten Feed.

Similar in appearance to the Buffalo, but the sample tested was rather inferior in composition. It is probably prepared from corn, in much the same way as the Buffalo gluten feed.

Chicago Maize Feed.

This feed is also prepared from corn. It is said to be a mixture of the yellow albuminous portion and the hulls without the germ. It contains, therefore, somewhat less fat than the gluten feeds. The hulls are not ground quite as fine.

Chicago Gluten Meal.

This is the yellow albuminous portion of the corn kernel. It contains much less fat than the other gluten meals. It was in good mechanical condition, and quite dry.

King Gluten Meal.

This meal was ground very fine. It contained a very high percentage of fat (19 per cent.).

Atlas Meal.

This is a by-product obtained from corn or grain in the process of the manufacture of alcohol. The starch of the grain is converted into sugar by the action of diastase, and finally into alcohol by fermentation. The hull, gluten and germ are left behind. The meal is probably composed of these, together with an admixture of malt sprouts. It is rich in fat and albuminoids. It is made by the Atlas Distilling Company, Peoria, Ill.

Peanut Feed.

This material appears to be peanut shells finely ground, with a small admixture of the nut. It contained over 50 per cent. of cellulose.

Soja-bean Meal.

The beans were raised upon the grounds of the Hatch Experiment Station. The quantity necessary for the experiment was supplied through the kindness of Professor Brooks.

Rye Meal.

The rye was raised upon the station grounds, and was of good average quality.

Winter Wheat Bran.

A fair sample of genuine winter bran.

RESULTS OF THE EXPERIMENT.

Digestibility of the Foods.

	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Hay of mixed grasses (*a*),	1	4	59	62	50	58	59
Hay of mixed grasses (*d*),	1	3	55	57	47	58	57
Average of both samples,	2	7	57	60	49	58	58
Vetch and oats,	1	2	58	66	19	60	54
New-process linseed meal,	1	2	77	99	102?	83	87
Buffalo gluten feed,	1	2	90	100	94	89	89
Peoria gluten feed,	1	2	86	78	79	83	90
Chicago maize feed,	1	2	87	82	92	85	88
Chicago gluten meal,	1	2	93	22	97	91	97
King gluten meal,	1	2	85	-	95	92	84
Atlas meal,	1	2	80	106?	91	73	84
Peanut feed,	1	2	32	12	90	71	49
Soja-bean meal,	1	2	82	71	86	91	76
Rye meal,	1	2	87	-	64	84	92
Winter wheat bran,	1	2	62	14	67	78	72

COMMENTS ON THE RESULTS.

Hays.

The hays prove to be about as digestible as those tested a year ago, and correspond in digestibility very closely to the figures given by Wolff.

Vetch and Oats.

The vetch and oats hay appears, with the exception of the fat, to be about as digestible as good English hay.

New-process Linseed Meal.

This test corresponds fairly with those made a year ago. The animal appeared to have very thoroughly assimilated the fat of the meal.

Buffalo Gluten Feed.

This sample gives distinctly higher digestion percentages than the one tested a year ago. The reason for this cannot be given. The parallel tests in each case agree closely. Other samples will be procured and further tests made.

Peoria Gluten and Chicago Maize Feeds.

These two gluten feeds .correspond very closely one with the other in the amounts of digestible matter they contain. The Peoria feed was inferior in composition to the maize feed.

Chicago Gluten Meal.

As there is comparatively no cellulose in this and the King gluten meal, that ingredient is not to be considered. The Chicago meal shows an exceptional degree of digestibility, 93 per cent. of the entire meal having been assimilated.

King Gluten Meal.

The King gluten meal was also quite digestible, 85 per cent. of the total dry matter being assimilated.

Atlas Meal.

This meal has 80 per cent. of digestible matter. The protein is about 73 per cent. digestible. It is somewhat inferior to the gluten meals in digestibility, although, with the exception of the increased percentage of cellulose present, it resembles them in composition. The cellulose appears in this test to have been all digested. This meal is a valuable addition to our feed-stuff supply, if it can be bought at a reasonable price. Additional digestion tests will be made.

Peanut Feed.

This material is unquestionably of inferior feeding value. Its dry matter was but 32 per cent. digestible, and it contained 54 per cent. of cellulose, of which but 12 per cent. were digested. The fat and protein were quite well assimilated, but the percentages contained — especially that of the protein — were comparatively small. The extract matter was only 49 per cent. digestible.

Soja-bean Meal.

The test of this meal was not entirely satisfactory, the variations in the percentages of cellulose and fat digestible in case of the two sheep being too large. Wolff gives the results of but two single trials with this meal, which correspond fairly with the figures found in our trial.

Rye Meal.

Wolff gives no direct digestion coefficients for rye. Our results make it appear practically as digestible as the corn meal, the protein even more so.

Winter Wheat Bran.

The digestibility of this bran is practically the same as the spring bran reported last year. As these two brans appear to have also the same percentage composition, they should be worth the same price per ton. Different seasons might exert some influence on composition and digestibility.

DETAILS OF THE EXPERIMENT.

Dry Matter Determinations made at the Time of Weighing out the Different Foods, and Dry Matter in Manure excreted.

SHEEP I.

PERIODS.	Hay.	New-process Linseed Meal.	Peoria Gluten Feed.	King Gluten Meal.	Chicago Gluten Meal.	Rye Meal.	Winter Wheat Bran.	Waste.	Manure.
I.,	88.48	-	-	-	-	-	-	84.30	90.26
II.,	87.81	-	-	-	-	-	-	-	91.14
IV.,	85.99	89.39	-	-	-	-	-	-	92.98
VI.,	88.40	-	90.08	-	-	-	-	-	91.84
VIII.,	86.28	-	-	-	90.31	-	-	-	93.27
IX.,	86.49	-	-	91.62	-	-	-	-	91.77
XIII.,	87.19	-	-	-	-	85.74	-	-	94.95
XIV.,	86.31	-	-	-	-	-	86.29	-	93.25

SHEEP II.

I.,	88.48	-	-	-	-	-	-	-	89.58
II.,	87.81	-	-	-	-	-	-	-	91.33
VIII.,	86.28	-	-	-	90.31	-	-	-	93.14
IX.,	86.49	-	-	91.62	-	-	-	-	91.17
XIII.,	87.19	-	-	-	-	85.74	-	-	95.14
XIV.,	86.31	-	-	-	-	-	86.29	-	93.14

SHEEP III.

PERIODS.	Hay.	Vetch and Oats.	Buffalo Gluten Feed.	Chicago Maize Feed.	Peoria Gluten Feed.	Atlas Meal.	Peanut Feed.	Soja-bean Meal.	Waste.	Manure.
I.,	88.48	-	-	-	-	-	-	-	85.40	91.00
II.,	88.40	-	-	-	-	-	-	-	-	91.91
III.,	-	85.12	-	-	-	-	-	-	-	91.71
V.,	86.28	-	91.86	-	-	-	-	-	-	93.48
VII.,	86.49	-	-	89.72	-	-	-	-	-	91.34
X.,	84.66	-	-	-	-	91.04	-	-	-	94.56
XI.,	87.85	-	-	-	-	-	90.43	-	-	94.31
XII.,	86.31	-	-	-	-	-	-	90.22	-	93.20

SHEEP IV.

PERIODS.	Hay.	Vetch and Oats.	Buffalo Gluten Feed.	Chicago Maize Feed.	Peoria Gluten Feed.	Atlas Meal.	Peanut Feed.	Soja-bean Meal.	Waste.	Manure.
I., . . .	88.48	-	-	-	-	-	-	-	-	93.08
II., . . .	88.40	-	-	-	-	-	-	-	-	92.04
III., . . .	-	85.12	-	-	-	-	-	-	-	90.73
V., . . .	86.28	-	91.86	-	-	-	-	-	-	93.20
VI., . . .	87.19	-	-	-	89.72	-	-	-	-	94.88
VII., . .	86.49	-	-	89.72	-	-	-	-	-	91.49
X., . . .	84.66	-	-	-	-	91.04	-	-	-	94.46
XI., . . .	87.85	-	-	-	-	-	90.43	-	-	94.14
XII., . . .	86.31	-	-	-	-	-	-	90.22	-	93.20

Composition of Feed Stuffs.

[Dry Matter.]

	Crude Ash (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Hay (*a*), ...	7.09	32.09	3.23	11.17	46.42
Hay (*b*), ...	7.99	32.50	2.29	9.74	47.48
Hay (*c*), ...	7.28	33.43	2.54	9.74	47.01
Hay (*d*) (average *b* and *c*), . . .	7.63	32.96	2.41	9.74	47.24
Vetch and oats, ...	10.65	35.95	2.61	13.42	37.37
Winter wheat bran, ...	7.59	10.64	4.97	15.61	61.19
Soja-bean meal, ...	6.20	4.50	18.89	38.47	31.94
New-process linseed meal, ...	6.02	8.04	4.30	41.38	40.26
Chicago maize feed, ...	0.80	9.06	9.00	26.13	55.01
Buffalo gluten feed, ...	0.40	8.46	13.32	22.93	54.89
Peoria gluten feed, ...	0.84	8.30	6.27	19.24	65.35
Chicago gluten meal, ...	0.14	1.78	4.60	37.09	56.44
King gluten meal, ...	1.50	1.41	19.68	38.57	38.84
Peanut feed, ...	5.06	54.40	5.54	12.06	22.94
Rye meal, ...	1.16	1.79	1.79	13.63	81.63
Atlas meal, ...	1.03	9.73	42.63	15.77	30.84
Waste, Sheep I., ...	10.91	30.88	3.42	12.21	42.58
Waste, Sheep III., ...	9.95	32.16	3.10	11.37	43.42

Composition of Fæces.

[Dry Matter.]

SHEEP I.

	Crude Ash (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Period I.					
Hay (*a*), ...	9.01	29.92	3.89	11.21	45.97
Period XIV.					
Hay (*a*) and winter wheat bran, .	11.41	28.19	4.61	10.57	45.22
Period VIII.					
Hay (*a*) and Chicago gluten meal, .	9.01	28.41	3.86	13.84	44.88
Period IX.					
Hay (*a*) and King gluten meal, .	9.50	27.28	4.73	12.68	45.81
Period IV.					
Hay (*a*) and new-process linseed meal, ...	10.00	29.78	3.26	14.50	42.46
Period II.					
Hay (*b*), ...	11.40	31.34	2.65	9.06	45.55
Period VI.					
Hay (*d*) and Peoria gluten feed, .	10.75	29.88	3.47	10.94	44.96
Period XIII.					
Hay (*d*) and rye meal, . . .	11.08	30.05	3.20	10.44	45.23

SHEEP II.

	Crude Ash (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Period I.					
Hay (*a*), ...	8.37	29.96	3.75	11.54	46.38
Period XIV.					
Hay (*a*) and winter wheat bran, .	11.78	27.33	3.58	10.73	46.58
Period VIII.					
Hay (*a*) and Chicago gluten meal, .	8.86	29.28	3.84	12.94	45.08
Period IX.					
Hay (*a*) and King gluten meal, .	9.06	29.21	3.87	12.19	45.67
Period II.					
Hay (*b*), ...	11.92	30.40	2.57	10.18	44.93
Period XIII.					
Hay (*d*) and rye meal, . . .	10.24	29.49	3.10	9.72	47.45

SHEEP III.

	Crude Ash (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.)	Extract Matter (Per Cent.).
Period I.					
Hay (*a*), ...	9.30	28.94	4.35	11.75	45.66
Period XII.					
Hay (*a*) and soja-bean meal, . .	11.21	25.89	6.26	12.54	44.10
Period V.					
Hay (*a*) and Buffalo gluten feed, .	8.76	26.81	4.50	12.72	47.21
Period VII.					
Hay (*a*) and Chicago maize feed, .	8.26	27.29	4.29	13.81	46.35
Period III.					
Vetch and oats, ...	11.81	29.88	5.18	12.51	40.62
Period II.					
Hay (c), ...	10.67	31.53	3.07	9.18	45.55
Period XI.					
Hay (*d*) and peanut feed, . .	9.70	49.96	1.92	7.25	31.17
Period X.					
Hay (*d*) and atlas meal, . . .	11.39	27.49	3.24	15.21	42.67

SHEEP IV.

	Crude Ash (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.)	Extract Matter (Per Cent.).
Period I.					
Hay (*a*), ...	9.23	28.96	3.89	10.90	47.02
Period XII.					
Hay (*a*) and soja-bean meal, . .	9.77	25.76	5.17	12.61	46.69
Period V.					
Hay (*a*) and Buffalo gluten feed, .	8.85	26.47	4.20	12.89	47.59
Period VII.					
Hay (*a*) and Chicago maize feed, .	7.87	27.48	4.13	13.31	47.21
Period III					
Vetch and oats, ...	12.12	28.43	4.96	13.31	41.18
Period II.					
Hay (*c*), ...	11.93	31.26	2.99	8.94	44.88
Period XI.					
Hay (*d*) and peanut feed, . .	8.07	48.75	1.95	7.37	33.86
Period VI.					
Hay (*d*) and Peoria gluten feed, .	11.45	28.04	3.84	10.60	46.07
Period X.					
Hay (*d*) and atlas meal, . . .	12.32	26.21	3.49	15.38	42.60

Tables showing Food fed and Water drank Daily, the Daily Amount of Manure excreted and the Temperature of the Stables.

Period I.

[Food consumed daily: 900 grams hay (*a*) and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Sheep I.			Sheep II.		
		Manure excreted Daily.*	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
March 29, .	37.0	874	34.06	2,035	926	33.30	2,002
30, .	44.0	865	37.78	2,068	1,010	48.08	1,780
31, .	35.5	805	31.30	2,055	989	37.86	1,542
April 1, .	54.5	833	34.06	2,128	1,040	36.76	1,860
2, .	46.0	819	30.58	2,202	903	34.60	1,490
3, .	37.5	908	39.99	2,167	834	34.55	1,570
4, .	41.5	808	32.18	2,047	812	32.93	1,610
Averages, .	42.3	845	34.27	2,100	931	36.87	1,693

* One-tenth preserved as daily sample in all cases except Period IV.

Weight of Sheep I. at beginning of period, ... 115.00 lbs.
Weight of Sheep II. at beginning of period, ... 117.00 "
Weight of Sheep I. at end of period, ... 114.50 "
Weight of Sheep II. at end of period, ... 117.50 "

[Food consumed daily: 900 grams hay (*a*) and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Sheep III.			Sheep IV.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
March 29, .	37.0	823	31.55	1,935	687	33.71	1,415
30, .	44.0	890	37.04	2,258	621	31.44	1,694
31, .	35.5	909	33.00	1,682	690	33.07	1,263
April 1, .	54.5	1,158	39.31	1,319	739	35.37	1,609
2, .	46.0	897	31.97	1,428	709	34.47	1,990
3, .	37.5	791	32.75	1,670	642	29.83	1,159
4, .	41.5	733	30.45	1,943	680	32.35	1,690
Averages, .	42.3	886	33.72	1,748	681	32.89	1,546

Weight of Sheep III. at beginning of period, ... 115.25 lbs.
Weight of Sheep IV. at beginning of period, ... 115.75 "
Weight of Sheep III. at end of period, ... 118.50 "
Weight of Sheep IV. at end of period, ... 117.25 "

PERIOD II.

[Food consumed daily: 900 grams hay (*b*) and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	SHEEP I.			SHEEP II.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
September 27, .	58.0	900	36.93	1,685	1,176	41.69	1,693
28, .	64.0	938	40.81	1,861	1,182	40.84	1,749
29, .	69.5	914	39.00	1,838	1,037	36.10	1,531
30, .	62.0	996	43.41	2,208	-	-	-
October 1, .	-	903	37.23	1,353	-	-	-
2, .	59.5	982	41.55	2,078	-	-	-
3, .	-	1,003	40.85	1,645	-	-	-
Averages, .	62.6	948	39.98	1,810	1,132	39.54	1,658

Weight of Sheep I. at beginning of period, ... 116.50 lbs.
Weight of Sheep II. at beginning of period, ... 114.00 "
Weight of Sheep I. at end of period, ... 116.50 "
Weight of Sheep II. at end of period, ... -* "

* Not determined.

[Food consumed daily: 900 grams hay (*c*) and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	SHEEP III.			SHEEP IV.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
October 7, .	58.0	804	39.75	1,090	998	39.86	1,685
8, .	57.0	814	39.39	950	1,134	39.16	1,543
9, .	62.5	753	37.48	1,325	1,003	38.88	1,402
10, .	52.5	806	40.56	1,193	909	37.26	2,202
11, .	55.0	880	41.87	1,175	1,081	37.82	468
12, .	57.5	740	36.15	1,063	813	36.57	1,951
13, .	51.0	812	39.78	1,200	778	35.53	1,787
Averages, .	56.2	801	39.20	1,142	959	37.87	1,577

Weight of Sheep III. at beginning of period, ... 118.75 lbs.
Weight of Sheep IV. at beginning of period, ... 116.50 "
Weight of Sheep III. at end of period, ... 118.00 "
Weight of Sheep IV. at end of period, ... 116.50 "

PERIOD III.

[Food consumed daily: 900 grams vetch and oats and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	SHEEP III.			SHEEP IV.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
September 23, .	64.0	842	30.84	2,115	1,003	33.58	2,325
24, .	64.0	903	34.65	2,435	1,086	39.97	2,500
25, .	61.0	1,262	41.04	2,500	966	34.04	2,500
26, .	57.0	1,311	35.98	2,500	1,018	35.30	2,500
27, .	58.0	1,061	36.36	3,160	1,049	34.48	3,483
28, .	64.0	1,046	37.52	2,062	1,018	34.32	2,063
29, .	62.0	1,029	38.83	1,538	1,017	35.69	2,321
Averages, .	61.4	1,065	37.88	2,330	1,022	35.34	2,527

Weight of Sheep III. at beginning of period, ... 119.50 lbs.
Weight of Sheep IV. at beginning of period, ... 118.50 "
Weight of Sheep III. at end of period, ... 119.00 "
Weight of Sheep IV. at end of period, ... 117.00 "

PERIOD IV.

[Food consumed daily: 600 grams hay (*a*), 200 grams new-process linseed meal and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	SHEEP I.		
		Manure excreted Daily.*	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.
May 31, ...	56.5	567	58.80	2,358
June 1, ...	62.0	536	49.43	2,500
2, ...	57.5	680	62.82	1,700
3, ...	64.0	562	49.30	1,388
4, ...	70.0	583	52.35	2,450
5, ...	59.5	679	56.59	2,455
6, ...	56.0	558	50.12	1,935
Averages, ...	60.8	595	54.20	2,112

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* One-fifth of total amount excreted preserved as daily sample; in all other periods one-tenth preserved.

Weight of animal at beginning of period, ... 117.00 lbs.
Weight of animal at end of period, ... 115.75 "

PERIOD V.

[Food consumed daily: 600 grams hay (*a*), 250 grams Buffalo gluten feed and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	SHEEP III. Manure excreted Daily.	SHEEP III. Sample Air Dry.	SHEEP III. Water drank Daily.	SHEEP IV. Manure excreted Daily.	SHEEP IV. Sample Air Dry.	SHEEP IV. Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
May 2, . .	76.5	544	24.67	2,077	572	25.82	2,013
3, . .	70.0	519	24.28	1,865	521	23.05	2,337
4, . .	61.5	588	25.29	1,928	471	22.36	2,093
5, . .	55.0	647	28.06	1,588	598	27.84	1,865
6, . .	70.0	624	27.08	1,829	511	24.44	2,078
7, . .	71.5	585	23.67	1,988	511	23.99	1,872
8, . .	-	600	24.13	1,961	565	27.11	1,754
Averages, .	67.4	580	25.31	1,884	536	24.94	1,930

Weight of Sheep III. at beginning of period, ... 115.75 lbs.
Weight of Sheep IV. at beginning of period, ... 116.50 "
Weight of Sheep III. at end of period, ... 115.00 "
Weight of Sheep IV. at end of period, ... 115.50 "

PERIOD VI.

[Food consumed daily by Sheep I.: 550 grams hay (*d*), 250 grams Peoria gluten feed and 5 grams salt; food consumed daily by Sheep IV.: 600 grams hay (*d*), 250 grams Peoria gluten feed and 5 grams salt.]

DATE.	SHEEP I. Stable Temperature (Fahr.).	SHEEP I. Manure excreted Daily.	SHEEP I. Sample Air Dry.	SHEEP I. Water drank Daily.	SHEEP IV.* Stable Temperature (Fahr.).	SHEEP IV.* Manure excreted Daily.	SHEEP IV.* Sample Air Dry.	SHEEP IV.* Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Degrees.	Grams.	Grams.	Grams.
October 12, .	56.5	534	22.10	1,638	-	-	-	-
13, .	51.0	641	26.51	1,080	36.5	569	26.61	943
14, .	54.0	649	25.73	1,105	41.5	600	28.00	632
15, .	48.5	768	33.69	2,100	48.0	628	28.59	647
16, .	48.0	730	30.05	1,840	44.0	497	24.23	1,181
17, .	55.5	694	28.07	892	39.0	607	25.81	1,625
18, .	51.0	655	28.18	1,687	39.0	844	33.10	825
19, .	-	-	-	-	-	850	28.79	1,133
Averages,	52.1	667	27.76	1,477	41.3	656	27.88	998

* The period for Sheep IV. occupied the dates November 13-19 inclusive.

Weight of Sheep I. at beginning of period, ... 111.75 lbs.
Weight of Sheep IV. at beginning of period, ... 113.50 "
Weight of Sheep I. at end of period, ... 113.50 "
Weight of Sheep IV. at end of period, ... 113.25 "

PERIOD VII.

[Food consumed daily: 600 grams hay (*a*), 250 grams Chicago maize feed and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	SHEEP III.			SHEEP IV.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
May 15, . .	60.5	594	27.00	2,137	611	28.73	2,325
16, . .	58.0	573	26.21	2,114	507	23.24	2,441
17, . .	64.0	537	23.92	1,730	567	28.00	2,013
18, . .	65.0	613	28.46	1,770	523	25.93	1,830
19, . .	64.5	528	24.93	1,640	518	23.68	2,319
20, . .	63.0	351	15.76	1,784	586	27.31	1,507
21, . .	57.0	1,054	37.09	1,255	620	29.44	1,125
Averages, .	61.7	607	26.20	1,776	562	26.62	1,866

Weight of Sheep III. at beginning of period, ... 117.00 lbs.
Weight of Sheep IV. at beginning of period, ... 117.00 "
Weight of Sheep III. at end of period, ... 119.50 "
Weight of Sheep IV. at end of period, ... 120.00 "

PERIOD VIII.

[Food consumed daily: 650 grams hay (*a*), 200 grams Chicago gluten meal and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	SHEEP I.			SHEEP II.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
May 1, . .	70.0	534	24.12	2,253	794	23.08	2,109
2, . .	76.5	642	26.72	2,457	820	26.74	2,426
3, . .	70.0	636	25.65	3,428	821	26.60	2,105
4, . .	61.5	658	26.51	2,160	727	25.37	1,864
5, . .	55.0	669	26.97	1,968	822	28.83	1,774
6, . .	70.0	777	29.15	2,352	684	24.39	1,915
7, . .	71.5	714	24.47	2,500	723	26.28	2,115
Averages, .	67.8	661	26.23	2,444	770	25.90	2,044

Weight of Sheep I. at beginning of period.. . . . 113.25 lbs.
Weight of Sheep II. at beginning of period, . . . 117.25 "
Weight of Sheep I. at end of period, ... 112.75 "
Weight of Sheep II. at end of period, ... 117.75 "

PERIOD IX.

[Food consumed daily: 650 grams hay (*a*), 200 grams King gluten meal and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	SHEEP I.			SHEEP II.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
May 15, . .	60.5	645	28.45	3,008	682	25.71	1,836
16, . .	58.0	647	30.42	3,721	675	32.47	2,167
17, . .	64.0	677	29.57	1,968	670	27.60	2,123
18, . .	65.0	499	21.20	2,500	789	29.35	2,065
19, . .	64.5	653	28.27	2,406	673	26.47	1,869
20, . .	63.0	590	26.67	2,218	710	25.86	1,952
21, . .	57.0	657	29.26	2,252	810	28.93	2,016
Averages, .	61.7	624	27.69	2,582	716	28.48	2,004

Weight of Sheep I. at beginning of period,. . . .	114.75 lbs.
Weight of Sheep II at beginning of period, . . .	118.00 "
Weight of Sheep I. at end of period, ...	116.50 "
Weight of Sheep II. at end of period, ...	119.25 "

PERIOD X.

[Food consumed daily: 650 grams hay (*d*), 200 grams atlas meal and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	SHEEP III.			SHEEP IV.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
December 1, .	32.0	610	34.89	57	994	33.00	1,103
2, .	-	526	25.87	2,264	754	29.19	1,758
3, .	41.0	606	30.06	968	671	24.72	936
4, .	33.0	684	32.16	897	856	35.23	1,597
5, .	31.5	635	30.22	873	747	33.49	730
6, .	27.0	626	28.91	690	556	26.00	1,372
7, .	33.0	692	29.05	1,397	624	29.22	1,292
Averages, .	32.9	626	30.17	1,021	743	30.12	1,255

Weight of Sheep III. at beginning of period, . . .	117.00 lbs.
Weight of Sheep IV. at beginning of period, . . .	113.50 "
Weight of Sheep III. at end of period, ...	119.50 "
Weight of Sheep IV. at end of period, ...	117.50 "

Period XI.

[Food consumed daily: 550 grams hay (*d*), 300 grams peanut feed and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Sheep III.			Sheep IV.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
October 28, .	48.0	820	42.72	988	762	46.61	750
29, .	57.0	788	43.03	1,213	808	46.38	1,068
30, .	51.0	818	44.49	928	766	43.47	2,038
31, .	56.5	792	40.17	1,150	735	42.39	25
November 1, .	52.5	784	42.29	1,285	685	38.81	1,677
2, .	60.0	773	40.53	994	777	41.89	875
3, .	59.0	852	45.43	1,080	704	38.98	1,912
Averages, .	54.9	803	42.67	1,091	748	42.65	1,192

Weight of Sheep III. at beginning of period, . . .	114.50 lbs.
Weight of Sheep IV. at beginning of period, . . .	113.00 "
Weight of Sheep III. at end of period, ...	115.00 "
Weight of Sheep IV. at end of period, ...	113.00 "

Period XII.

[Food consumed daily: 600 grams hay (*d*), 250 grams soja-bean meal and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Sheep III.			Sheep IV.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
April 13, . .	46.0	697	26.70	1,828	629	25.40	1,705
14, . .	50.0	727	34.55	1,669	649	25.09	2,133
15, . .	55.5	559	29.00	1,280	729	36.68	1,886
16, . .	56.0	577	24.20	1,645	596	24.42	1,530
17, . .	59.5	679	28.17	2,066	603	22.84	2,091
18, . .	58.0	583	24.25	1,187	634	22.92	2,255
19, . .	60.0	705	29.45	1,905	697	26.39	2,322
Averages, .	55.0	647	28.05	1,654	648	26.25	1,989

Weight of Sheep III. at beginning of period, . . .	114.00 lbs.
Weight of Sheep IV. at beginning of period, . . .	113.50 "
Weight of Sheep III. at end of period, ...	112.75 "
Weight of Sheep IV. at end of period, ...	114.00 "

PERIOD XIII.

[Food consumed daily: 550 grams hay (*d*), 300 grams rye meal and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	SHEEP I.			SHEEP II.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
November 13, .	36.5	680	28.44	1,088	588	25.33	670
14, .	41.5	584	25.34	1,250	644	27.35	883
15, .	48.0	598	27.21	1,220	646	27.50	692
16, .	44.0	638	25.73	1,490	616	27.10	1,065
17, .	39.0	585	23.76	1,780	617	26.66	1,327
18, .	39.0	618	24.50	1,121	583	25.09	354
19, .	-	608	24.09	836	668	27.99	1,092
Averages, .	41.3	616	25.58	1,255	622	26.72	869

Weight of Sheep I. at beginning of period, ... 113.00 lbs.
Weight of Sheep II. at beginning of period, . . . 113.00 "
Weight of Sheep I. at end of period, ... 113.00 "
Weight of Sheep II. at end of period, ... 113.00 "

PERIOD XIV.

[Food consumed daily: 600 grams hay (*a*), 300 grams winter wheat bran and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	SHEEP I.			SHEEP II.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
April 13, . .	46.0	1,181	38.21	1,644	1,017	31.64	1,669
14, . .	50.0	989	31.82	1,869	1,093	34.24	1,523
15, . .	55.5	1,002	33.28	2,225	983	30.62	2,061
16, . .	56.0	978	32.47	2,108	1,116	33.30	2,009
17, . .	59.5	1,080	34.40	2,145	1,172	34.45	1,803
18, . .	58.0	959	32.19	2,161	1,124	33.09	1,847
19, . .	60.0	1,057	33.40	2,304	1,167	32.48	2,193
Averages, .	55.0	1,035	33.68	2,065	1,096	32.88	1,872

Weight of Sheep I. at beginning of period, . . . 114.25 lbs.
Weight of Sheep II. at beginning of period, . . . 117.00 "
Weight of Sheep I. at end of period, ... 113.75 "
Weight of Sheep II. at end of period, ... 117.00 "

The data presented in the preceding tables enable us to calculate the digestion coefficients, which follow: —

PERIOD I.

English Hay (*a*).

SHEEP I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
900 grams hay fed, ...	796.32	255.53	25.72	88.94	369.64
72 grams waste, ...	60.69	18.74	2.08	7.41	25.84
Total consumed, ...	735.63	236.79	23.64	81.53	343.80
342.71 grams manure air dry, . .	309.47	92.59	12.03	34.69	142.16
Grams digested, ...	426.16	144.20	11.61	46.84	201.64
Per cent. digested, ...	57.93	60.90	49.11	57.45	58.65

SHEEP II.

900 grams hay fed, ...	796.32	255.53	25.72	88.94	369.64
368.66 grams manure air dry, . .	330.54	99.03	12.39	38.14	153.30
Grams digested, ...	465.78	156.50	13.33	50.80	216.34
Per cent. digested, ...	58.49	61.24	51.82	57.11	58.52

SHEEP III.

900 grams hay fed, ...	796.32	255.53	25.72	88.94	369.64
73 grams waste, ...	62.34	20.04	1.93	7.08	27.06
Total consumed, ...	733.98	235.49	23.79	81.86	342.58
337.27 grams manure air dry, . .	307.02	88.85	13.35	36.07	140.19
Grams digested, ...	426.96	146.64	10.44	45.79	202.39
Per cent. digested, ...	58.17	62.27	43.88	55.88	59.07

SHEEP IV.

900 grams hay fed, ...	796.32	255.53	25.72	88.94	369.64
328.91 grams manure air dry, . .	306.02	88.62	11.90	33.35	143.89
Grams digested, ...	490.30	166.91	13.82	55.59	225.75
Per cent. digested, ...	61.57	65.32	53.73	62.49	61.07
Average per cent. digested, . . .	59.04	62.44	49.63	58.23	59.33

Average nutritive ratio of ration for four sheep, 1 : 8.00.

PERIOD II.

English Hay (*b*).

SHEEP I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
900 grams hay fed, ...	790.30	256.84	18.10	76.97	375.24
399.76 grams manure air dry, . .	364.34	114.19	9.65	32.97	166.00
Grams digested, ...	425.96	142.65	8.45	44.00	209.24
Per cent. digested, ...	53.89	55.54	46.67	57.16	55.76

SHEEP II.

900 grams hay fed, ...	790.30	256.84	18.10	76.97	375.24
395.43 grams manure air dry, . .	361.15	109.79	9.29	36.76	162.27
Grams digested, ...	429.15	147.06	8.81	40.21	212.97
Per cent. digested, ...	54.33	57.25	48.65	52.23	56.76

English Hay (*c*).

SHEEP III.

900 grams hay fed, ...	795.60	265.96	20.21	77.49	374.01
392.01 grams manure air dry, . .	360.26	113.60	11.06	33.07	164.10
Grams digested, ...	435.34	152.36	9.15	44.42	209.91
Per cent. digested, ...	54.72	57.30	45.28	57.32	56.12

SHEEP IV.

900 grams hay fed, ...	795.60	265.96	20.21	77.49	374.01
378.69 grams manure air dry, . .	348.44	108.92	10.41	31.15	156.38
Grams digested, ...	447.16	157.04	9.80	46.34	217.63
Per cent. digested, ...	56.20	59.04	48.50	59.82	58.19
Average per cent. digested, . . .	54.94	57.29	46.82	58.10	56.69

Average nutritive ratio of ration for Sheep I., III. and IV., 1 : 8.59.

Hays *b* and *c* were from the same lot, but the tests were made at different times and two separate samples were taken. The average of the analyses of the two analyses and of the digestion coefficients from Sheep I., III. and IV. was used in computing the digestibility of the grains fed. This average has been called hay *d*. Sheep II., while the results are given above, was not included in the average. The period in case of this sheep lasted but three days, and the amount of protein digested is too low.

PERIOD III.

Vetch and Oats.

SHEEP III.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
900 grams vetch and oats fed, . .	766.08	275.41	19.99	102.81	286.30
364.5 grams manure air dry, . .	321.21	95.98	16.64	40.18	130.48
Grams digested, ...	444.87	179.43	3.35	62.63	155.82
Per cent. digested, ...	58.07	65.16	16.75	60.92	54.42

SHEEP IV.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
900 grams vetch and oats fed, . .	766.08	275.41	19.99	102.81	286.30
353.4 grams manure air dry, . .	320.68	91.17	15.91	42.68	132.06
Grams digested, ...	445.40	184.24	4.08	60.13	154.24
Per cent. digested, ...	58.14	66.88	20.40	58.48	53.88
Average per cent. digested, . . .	58.10	66.02	18.57	59.70	54.15

Average nutritive ratio of ration for two sheep, 1 : 5.64.

PERIOD IV.

New-process Linseed Meal.

SHEEP I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
600 grams hay fed, ...	516.00	165.50	16.66	57.63	239.42
200 grams new-process linseed meal, .	178.80	14.38	7.68	73.98	71.98
Total consumed, ...	694.80	179.88	24.34	131.61	311.40
271.04 grams manure air dry, . .	252.06	75.06	8.21	36.54	107.02
Amount digested, . . .	442.74	104.82	16.13	95.07	204.38
Minus hay digested, ...	304.63	103.39	8.27	33.57	142.04
Remains linseed meal digested, . .	138.11	1.43	7.86	61.50	62.34
Per cent. digested, ...	77.24	99.47	102.20?	83.12	86.60

Nutritive ratio of ration for one sheep, 1 : 3.68.

PERIOD V.

Buffalo Gluten Feed.

SHEEP III.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
600 grams hay fed, ...	517.68	166.12	16.72	57.82	240.31
250 grams Buffalo gluten feed, . .	229.82	19.44	30.61	52.69	126.15
Total consumed, ...	747.50	185.56	47.33	110.51	366.46
253.11 grams manure air dry, . .	236.61	63.43	10.64	30.10	111.70
Total digested, ...	510.89	122.13	36.69	80.41	254.76
Minus hay digested, ...	305.64	103.72	8.30	33.67	142.57
Remains gluten feed digested, . .	205.25	18.41	28.39	46.74	112.19
Per cent. digested, ...	89.35	94.69	92.74	88.69	88.93

SHEEP IV.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
Total consumed, as above, . .	747.50	185.56	47.33	110.51	366.46
249.43 grams manure air dry, . .	232.46	61.51	9.76	30.00	110.65
Total digested, ...	515.04	124.05	37.57	80.51	255.81
Minus hay digested, ...	305.64	103.72	8.30	33.67	142.57
Remains gluten feed digested, . .	209.40	20.33	29.27	46.84	113.24
Per cent. digested, ...	91.11	104.56?	95.61	88.88	89.76
Average per cent. two sheep digested,	90.23	99.60	94.17	88.78	89.34

Average nutritive ratio of ration for two sheep, 1 : 5.85.

PERIOD VI.

Peoria Gluten Feed.

SHEEP I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
550 grams hay fed, ...	486.20	160.30	11.76	47.35	229.97
250 grams Peoria gluten feed, . .	225.20	18.69	14.12	43.32	147.16
Total consumed, ...	711.40	178.99	25.88	90.67	377.13
277.61 grams manure air dry, . .	254.96	76.19	8.84	27.89	114.64
Amount digested, ...	456.44	102.80	17.04	62.79	262.49
Minus hay digested, ...	267.11	91.83	5.51	27.51	130.37
Remains gluten feed digested, . .	189.33	10.97	11.53	35.28	132.12
Per cent. digested, ...	84.07	58.69	81.68	81.42	89.77

PERIOD VI. (*Peoria Gluten Feed*) — Concluded.

SHEEP IV.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
600 grams hay fed,	523.20	172.50	12.66	50.96	247.47
250 grams Peoria gluten feed,	224.30	18.62	14.06	43.15	146.58
Total consumed,	747.50	191.12	26.72	94.11	394.05
278.76 grams manure air dry,	264.49	74.16	10.16	28.03	121.85
Amount digested,	483.01	116.96	16.56	66.08	272.20
Minus hay digested,	287.44	98.82	5.93	29.60	140.29
Remains gluten feed digested,	195.57	18.14	10.63	36.48	131.91
Per cent. digested,	87.19	97.44	75.58	84.53	89.99
Average per cent. two sheep digested,	85.63	78.06	78.60	82.97	89.88

Average nutritive ratio of ration for two sheep, 1 : 6.50.

PERIOD VII.

Chicago Maize Feed.

SHEEP III.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
600 grams hay fed,	518.94	166.52	16.76	57.96	240.89
250 grams Chicago maize feed,	224.30	20.32	20.19	58.60	123.39
Total consumed,	743.24	186.84	36.95	116.56	364.28
261.96 grams manure air dry,	239.27	65.29	10.26	33.04	110.90
Amount digested,	503.97	121.55	26.69	83.52	253.38
Minus hay digested,	306.38	103.98	8.32	33.75	142.92
Remains gluten feed digested,	197.59	17.57	18.37	49.77	110.46
Per cent. digested,	88.09	86.45	91.00	84.92	89.52

SHEEP IV.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
Total consumed, as above,	743.24	186.84	36.95	116.56	364.28
266.19 grams manure air dry,	243.53	66.92	10.05	32.41	114.97
Total digested,	499.71	119.92	26.90	84.15	249.31
Minus hay digested,	306.38	103.98	8.32	33.75	142.92
Remains gluten feed digested,	193.33	15.94	18.58	50.40	106.39
Per cent. digested,	86.19	78.48	92.03	86.00	86.22
Average per cent. two sheep digested,	87.14	82.46	91.51	85.46	87.87

Average nutritive ratio of ration for two sheep, 1 : 5.25.

PERIOD VIII.

Chicago Gluten Meal.

SHEEP I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
650 grams hay fed, ...	560.82	179.96	18.11	62.64	260.33
200 grams Chicago gluten meal, . .	180.60	3.12	8.30	66.98	101.93
Total consumed, ...	741.42	183.08	26.41	129.62	362.26
262.27 grams manure air dry, . .	244.62	69.49	9.44	33.85	109.78
Total digested, ...	496.80	113.59	16.97	95.77	252.48
Minus hay digested, ...	331.11	112.37	8.99	36.47	154.45
Remains gluten meal digested, . .	165.69	1.22	7.98	59.30	98.03
Per cent. digested, ...	91.74	39.04	96.05	88.52	96.17

SHEEP II.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
Total consumed, as above, . .	741.42	183.08	26.41	129.62	362.26
258.84 grams manure air dry, . .	241.08	70.58	9.26	31.19	108.68
Total digested, ...	500.34	112.50	17.15	98.43	253.58
Minus hay digested, ...	331.11	112.37	8.99	36.47	154.45
Remains gluten meal digested, . .	169.23	.13	8.16	61.96	99.13
Per cent. digested, ...	93.70	4.16	98.22	92.49	97.25
Average per cent. two sheep digested,	92.72	21.60	97.13	90.50	96.71

Average nutritive ratio of ration for two sheep, 1 : 4.21.

PERIOD IX.

King Gluten Meal.

SHEEP I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
650 grams hay fed, ...	562.18	180.40	18.15	62.79	260.96
200 grams King gluten meal, . .	183.24	2.58	36.06	70.67	71.17
Total consumed, ...	745.42	182.98	54.21	133.46	332.13
276.91 grams manure air dry, . .	254.12	69.32	12.02	32.22	116.41
Amount digested, ...	491.30	113.66	42.19	101.24	215.72
Minus hay digested, ...	331.91	112.64	8.97	36.56	154.82
Remains gluten meal digested, . .	159.39	1.02	33.22	64.68	60.90
Per cent. digested, ...	86.98	39.47	92.12	91.52	85.57

PERIOD IX. (*King Gluten Meal*) — Concluded.

SHEEP II.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
Total consumed, as above, . .	745.42	182.98	54.21	183.46	332.13
284.84 grams manure air dry, . .	259.68	75.85	10.05	81.65	118.60
Amount digested, ...	485.74	107.13	44.16	101.81	213.53
Minus hay digested, ...	331.91	112.64	8.96	36.56	154.82
Remains gluten meal digested, . .	153.83	-	35.20	65.25	58.71
Per cent. digested, ...	83.96	-	97.63	92.34	82.44
Average per cent. two sheep digested,	85.47	-	94.87	91.93	84.00

Average nutritive ratio of ration for two sheep, 1 : 4.26.

PERIOD X.

Atlas Meal.

SHEEP III.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
650 grams hay fed, ...	550.35	181.45	18.31	53.60	260.32
200 grams atlas meal, ...	182.08	17.72	23.70	77.62	56.15
Total consumed, ...	732.43	199.17	42.01	131.22	316.47
301.66 grams manure air dry, . .	285.25	78.41	9.24	43.38	121.72
Total digested, ...	447.18	120.76	32.77	87.84	194.75
Minus hay digested, ...	302.36	108.95	6.23	31.14	147.58
Remains atlas meal digested, . .	144.82	16.81	26.54	56.70	47.17
Per cent. digested, ...	79.53	94.88	92.48	73.04	84.00

SHEEP IV.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
Total consumed, as above, . .	732.43	199.17	42.01	131.22	316.47
301.21 grams manure air dry, . .	284.52	74.57	9.92	43.76	121.21
Total digested, ...	447.91	124.60	32.09	87.46	195.26
Minus hay digested, ...	302.36	108.95	6.23	31.14	147.58
Remains atlas meal digested, . .	145.55	20.65	25.86	56.32	47.68
Per cent. digested, ...	79.75	116.50	90.06	72.56	84.91
Average per cent. two sheep digested,	79.64	105.70	91.24	72.80	84.45

Average nutritive ratio of ration for two sheep, 1 : 4.55,

PERIOD XI.

Peanut Feed.

SHEEP III.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
550 grams hay fed, ...	483.17	159.30	11.69	47.06	228.54
300 grams peanut feed, ...	271.29	147.58	15.03	32.72	62.23
Total consumed, ...	754.46	306.88	26.72	79.78	290.77
426.66 grams manure air dry, . .	402.39	201.03	7.72	29.17	125.41
Total digested, ...	352.07	105.85	19.00	50.61	165.36
Minus hay digested, ...	265.45	91.26	5.47	27.34	129.56
Remains peanut feed digested, . .	86.62	14.59	13.53	23.27	35.80
Per cent. digested, ...	31.93	9.88	90.01	71.12	57.52

SHEEP IV.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
Total consumed, as above, . .	754.46	306.88	26.72	79.78	290.77
426.47 grams manure air dry, . .	401.48	195.70	7.82	29.59	135.95
Total digested, ...	352.98	111.18	18.90	50.19	154.82
Minus hay digested, ...	265.45	91.26	5.47	27.34	129.56
Remains peanut feed digested, . .	87.53	19.92	13.43	22.85	25.26
Per cent. digested, ...	32.26	13.49	89.36	70.00	40.59
Average per cent. two sheep digested,	32.09	11.68	89.68	70.56	49.05

Average nutritive ratio of ration for two sheep, 1 : 6.27.

PERIOD XII.

Soja-bean Meal.

SHEEP III.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
600 grams hay fed, ...	517.86	166.18	16.72	57.84	240.29
250 grams soja-bean meal, ...	225.55	10.15	42.61	86.69	72.04
Total consumed, ...	743.41	176.33	59.33	144.53	312.33
280.46 grams manure air dry, . .	261.39	67.67	16.36	32.78	115.27
Total digested, ...	482.02	108.66	42.97	111.75	197.06
Minus hay digested, ...	305.75	103.76	8.34	33.68	142.62
Remains soja-bean meal digested, .	176.27	4.90	34.63	78.07	54.44
Per cent. digested, ...	78.15	48.27	81.28	89.97	75.57

PERIOD XII. (*Soja-bean Meal*) — Concluded.

SHEEP IV.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
Total consumed, as above, . .	743.41	176.33	59.33	144.53	312.33
262.49 grams manure air dry, . .	244.64	63.02	12.65	30.85	114.22
Total digested, ...	498.77	113.31	46.68	113.68	198.11
Minus hay digested, ...	305.73	103.76	8.30	33.68	142.62
Remains soja-bean meal digested, .	193.04	9.55	38.38	80.00	55.49
Per cent. digested, ...	85.58	94.09	90.09	92.20	77.02
Average per cent. two sheep digested,	81.86	71.18	85.88	91.08	76.29

Average nutritive ratio of ration for two sheep, 1: 3.73.

PERIOD XIII.

Rye Meal.

SHEEP I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
550 grams hay fed, ...	479.60	158.12	11.61	46.71	226.85
300 grams rye meal, ...	257.22	4.60	4.60	35.04	209.97
Total consumed, ...	736.82	162.72	16.21	81.75	436.82
255.81 grams manure air dry, . .	242.89	73.00	7.77	25.35	109.86
Total digested, ...	493.73	89.72	8.44	56.40	326.96
Minus hay digested, ...	263.49	90.58	5.43	27.14	128.60
Remains rye meal digested, . .	230.24	-	3.01	29.26	198.36
Per cent. digested, ...	89.51	-	65.37	83.46	94.47

SHEEP II.

Total consumed, as above, . .	736.82	162.72	16.21	81.75	436.82
267.15 grams manure air dry, . .	254.21	74.96	7.88	24.70	120.60
Total digested, ...	482.61	87.76	8.33	57.05	316.22
Minus hay digested, ...	263.49	90.58	5.43	27.14	128.60
Remains rye meal digested, . .	219.12	-	2.90	29.91	187.62
Per cent. digested, ...	85.18	-	62.98	85.31	89.34
Average per cent. two sheep digested,	87.34	-	64.17	84.38	91.90

Average nutritive ratio of ration for two sheep, 1: 7.60.

PERIOD XIV.

Winter Wheat Bran.

SHEEP I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
600 grams hay fed, ...	517.86	166.18	16.72	57.84	240.29
300 grams winter wheat bran, . .	258.81	27.53	12.86	40.40	158.37
Total consumed, ...	776.67	193.71	29.58	98.24	398.66
336.73 grams manure air dry, . .	313.86	88.47	14.46	33.17	141.93
Total digested, ...	462.81	105.24	15.12	65.07	256.73
Minus hay digested, ...	305.75	103.76	8.30	33.68	142.62
Remains winter wheat bran digested,	157.06	1.48	6.82	31.39	114.11
Per cent. digested, ...	60.68	5.37	53.02	77.69	72 05

SHEEP II.

Total consumed, as above, . .	776.67	193.71	29.58	98.24	398.66
328.31 grams manure air dry, . .	305.69	83.54	10.94	32.80	142.39
Total digested, ...	470.98	110.17	18.64	65.44	256.27
Minus hay digested, ...	305.75	103.76	8.30	33.68	142.62
Remains winter wheat bran digested,	165.23	6.41	10.34	31.76	113.65
Per cent. digested, ...	63.83	23.29	80.39	78.65	71.76
Average per cent. two sheep digested,	62.25	14.33	66.70	78.17	71.90

Average nutritive ratio of ration for two sheep, 1 : 6.23.

See tables containing compilation of all American digestion experiments, at the end of this report.

2. CONCERNING THE DIGESTIBILITY OF THE PENTOSANS.

By J. B. Lindsey and E. B. Holland.

During the past five or six years much attention has been given to the study of the pentosans. Fischer, Tollens, Schulze, Stone and many others have investigated their chemical character, and noted their very general occurrence in our woods and agricultural plants and seeds.

The pentosans have the composition $(C_5H_8O_4)n$, and by inversion with dilute mineral acids yield, so far as known, two sugars, namely, *xylose* and *arabinose*, $C_5H_{10}O_5$. The pentosan which yields xylose is more generally found in our agricultural plants. Pentoses[*] $(C_5H_{10}O_5)$ have been found to exist in the juices of a great variety of growing plants. Whether they are formed by direct assimilation, or from the hexoses, is not yet fully settled. Xylan and araban belong, generally speaking, to the so-called *hemicelluloses*. E. Schulze[†] has applied this name to those portions of the cellular structure of plants that are not soluble in water, but in dilute mineral acids. That they cannot always be strictly considered as hemicellulose is made clear from the recognition by Schulze and Winterstein[‡] of a pentosan in *amyloid*, a substance extracted with water from the seeds of *Tropæolum majus*. In some cases, also, they approach in character the true cellulose.[§] Schulze[‖] has also recognized the pentosans in the cotyledons and endosperms of many seeds, and they undoubtedly serve, just as do galactan, starch, etc., as a reserve material, supporting the life of the young plant during the process of germination. That the pentosans in the matured plants and seeds form a part of the cell walls and are dissolved during germination is quite clear from the numerous microscopic investigations made by Professor Cramer[*] and Dr. Pfister[†] in connection with Schulze's work.

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[*] G. de Chalmot, Am. Chem. Jour., **15**, 21.

[†] Zeitschr. f. physiol. Chemie, **14**.

[‡] Zeitschr. f. physiol. Chemie, **15**; Berichte der chem. Ges., **24**, 2277.

[§] Zeitschr. f. physiol. Chemie, **16**; also Winterstein *loco citato*.

[‖] *Loco citato*.

Concerning the value of the pentosans as a source of food for animals, the results of two investigations have been published. Stone[‡] fed corn meal and bran to rabbits, and found that about 60 per cent. of the pentosans were digested. A like conclusion was drawn by Stone and Jones,[§] as a result of the examination of the food and fæces of sheep fed upon the hay of different grasses. Ebstein[‖] has also shown that both xylose and arabinose are but little assimilated by human beings, these sugars being recognized in the urine a few hours after being eaten.

During the spring and autumn of 1893 the writer made digestion experiments with hay, corn cobs, brewers' grains and several concentrated fodder articles. These results have already been published.[¶] We have thought it of sufficient interest to determine the amount of pentosans in each of the foods fed and in the fæces excreted, and thus note their degree of digestibility.[**]

The method employed for determining the furfurol, and consequently the pentosans, was the one described by Flint and Tollens,[††] being a modification of the method originally introduced by de Chalmot and Tollens.[‡‡]

Pentosans differ from true carbohydrates in yielding furfurol instead of lævulinic acid when boiled with hydrochloric acid of a certain strength. Their detection and estimation depends upon the production and separation of furfurol, and its subsequent precipitation with phenyl-hydrazin as furfurol hydrazon.

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[*] Zeitschr. physiol. Chem., **14**, 227

[†] Zeitschr. physiol. Chem., **19**, 44.

[‡] Am. Chem. Jour., **14**, 9.

[§] Agricultural Science, **5**, 6.

[‖] Archiv. pathol. Anat., **129**, 401.

[¶] Massachusetts State Experiment Station, Eleventh Annual Report, 1893.

[**] While it is possible to estimate the amount of furfurol in the fæces with a fair degree of accuracy, it must be admitted that it is by no means certain that this furfurol is a true indicator of the amount of pentosans present; *i.e.*, it has not as yet been shown whether the pentosan molecule remains entirely intact during the digestive process. From our present knowledge it must be assumed that such is the case.

[††] E. R. Flint, Inaugural Dissertation, Göttingen, 1892; Landw. Vers. Stat., **42**, 398.

[‡‡] Inaugural Dissertation, Göttingen, 1891

Method.

Weigh out 3 to 5 grams (depending on the amount of pentosans present) of the finely ground material, and transfer to a 300 cubic centimeter flask. After adding 100 cubic centimeters of hydrochloric acid of 1.06 specific gravity, connect with a Liebig condenser, and distil 30 cubic centimeters, taking ten to fifteen minutes for the distillation. Instead of putting the flask in Rose's metal to diffuse the heat, as Flint and others suggest, we have placed it upon a piece of gauze with equally satisfactory results. Now add 30 cubic centimeters more acid by means of a separatory funnel (the stem of which passes through the cork into the flask), and so continue the process until a drop of the distillate gives no red coloration on filter paper that has been moistened with aniline acetate (a few drops of aniline in a little 50 per cent. acetic acid). Ten to eleven distillations are generally sufficient. Flint has shown that for constant results the presence of a certain amount of salt in a definite quantity of solution is essential. Furfurol hydrazon is more insoluble with 81 grams of sodium chloride in 400 cubic centimeters of distillate than when less is present, and these proportions should be always used. Add to the obtained distillate, brought into a 700 to 800 cubic centimeter beaker, the necessary amount of salt and water to raise it to this standard (see table following).

Distillate (Cubic Centimeters).	Water (Cubic Centimeters).	Salt to be added (Grams).
400	-	-
350	50	10.15
300	100	20.30
250	150	30.45
200	200	40.60
150	250	50.75
100	300	60.90
50	350	71.05
-	400	81.20

Neutralize exactly the 400 cubic centimeter solution with sodium carbonate, covering the beaker with a watch glass during the process, and make up to 500 cubic centimeters with water. Add now 10 cubic centimeters of phenyl-hydrazin solution,[*] precipitating the furfurol as furfurol hydrazon.[†] Stir thirty minutes, preferably with an automatic stirrer, and filter the solution, using suction, into glass drying tubes about three-quarters of an inch in diameter and six to seven inches long, drawn out at the lower end and filled with about one-half inch of glass wool in preference to asbestos. Remove adhering particles with a feather, and do not use over 100 cubic centimeters of wash water. Dry the precipitate in a specially constructed air bath (see cut) at 55° to 60° C. for three hours. To hasten and perfect the drying a partial vacuum is made by drawing dry air slowly through the tubes by aid of a suction pump, the air supply being regulated by pinchcocks. The air before entering the tubes is conducted through sulphuric acid to dry it, and through a glass tube containing small pieces of marble to remove any sulphuric acid that might be carried over mechanically. Cool the tubes in a desiccator and weigh. Dissolve out the precipitate with hot alcohol and reweigh, and consider the loss in weight as furfurol hydrazon. (See cut of apparatus at end of this article.)

For the conversion of furfurol hydrazon to furfurol use the following factors: —

Furfurol = furfurol hydrazon × 0.538.
Arabinose = furfurol hydrazon × 1.229 + 0.0177.
Xylose = furfurol hydrazon × 1.031 — 0.001.
Pentose (average arabinose and xylose) = furfurol hydrazon × 1.13 + 0.0083.
Pentosan = pentose × 0.88.

Formulas.

Furfurol = C^4H^3O-COH.
Phenyl-hydrazin = $C^6H^5-NH-NH^2$.
Furfurol hydrazon = $C^4H^3O\,CH\,C^6H^5N^2H$.
Pentose = $(C^5H^{10}O^5)$ n.
Pentosans = $(C^5H^8O^4)$ n.

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[*] Twelve grams of phenyl-hydrazin and 7.5 grams of glacial acetic acid filled to 100 cubic centimeters with water and well shaken.

[†] After the addition of the phenyl-hydrazin reagent, the solution should react *slightly* acid. In case this is not so, add the necessary acetic acid.

In Table I. will be found the percentages of furfurol, pentosans and extract matter found in the feeds consumed. It will be seen that the pentosans equal from one-third to one-half of the extract matter.

Table II. shows the percentages of pentosans in the excreta of the sheep during the different feeding periods.

TABLE I. — *Pentosans in Food tested.**

No. of Period.	FOODS TESTED.	Dry Matter (Per Cent.).	No. of Grams taken for Furfurol Estimation.	AIR-DRY MATERIAL. Furfurol Hydrazon found (Grams).		DRY MATTER.		
				a.	b.	Equivalent Per Cent. Furfurol.	Equivalent Per Cent. Pentosans.	Per Cent. Nitrogen-free Extract.
1	Hay (*a*), ...	94.09	4	0.7633	0.7656	10.93	20.41	48.51
2	Buffalo gluten feed, . .	92.92	5	0.7968	0.7913	9.20	17.16	50.20
3	Hay (*b*), ...	93.63	3	0.6140	0.6393	12.00	22.43	45.56
4	New-process linseed meal,	91.75	4	0.4860	0.4950	7.19	13.49	41.16
5	Old-process linseed meal,	90.81	4	0.4807	0.4916	6.54	13.49	39.80
6	Corn cobs, ...	92.27	3	0.8643	0.8651	16.80	31.34	65.77
7	Dried brewers' grains, .	93.46	4	0.9205	0.9111	13.17	24.57	51.09
8	Spring wheat bran, . .	92.72	3	{0.8188 {0.7902	0.8111	15.60	29.07	59.39
9	Winter wheat bran, . .	91.49	3	{0.6877 {0.6675	0.6620	13.17	24.63	62.83

* In a former article, published in "Agricultural Science," concerning the digestibility of the pentosans, the percentages of pentosans were calculated by multiplying the per cent. of furfurol by 1.38. This was the old way, and if none of the pentosans were destroyed in the process of distillation it would give the correct percentage. It gives, however, considerably lower percentages than when the formula as suggested by Flint is used. The digestion coefficients would not be affected, however. In the present calculations we have used Flint's formula, believing it to be much nearer correct.

TABLE II. — *Pentosans in Manure excreted.*

No. of Period.	Foods Tested.	Dry Matter (Per Cent.).	Grams taken for Furfurol Estimation.	Air-dry Material. Furfurol Hydrazon found (Grams).		Dry Matter.	
				a.	*b.*	Equivalent Per Cent. Furfurol.	Equivalent Per Cent. Pentosans.
	Hay (a).						
I.	Sheep II., ...	92.96	4	0.6996	0.7210	10.27	19.20
	Sheep III., ...	93.33	4	0.6990	0.7060	10.12	18.92
	Sheep IV., ...	92.34	4	0.7395	0.7358	10.74	20.06
	Buffalo Gluten Feed.						
II.	Sheep II., ...	91.54	5	0.8520	0.8630	10.07	18.76
	Sheep IV., ...	92.20	5	0.8758	0.8824	10.26	19.13
	Hay (b).						
III.	Sheep I., ...	93.00	4	0.6880 0.6920	0.7190	10.10	18.91
	Sheep II., ...	92.59	4	0.7390	0.7310	10.67	19.94
	Sheep III., ...	92.38	4	0.6804	0.7149	10.15	18.98
	Sheep IV., ...	91.74	4	0.6657	0.6596	9.71	18.16
	New-process Linseed Meal.						
IV.	Sheep II., ...	94.62	3	0.5210	0.5165	9.83	18.45
	Sheep III., ...	94.57	4	0.6387	-	9.08	16.97
	Old-process Linseed Meal.						
V.	Sheep II., ...	94.62	4	0.6762	0.6476	9.41	17.60
	Sheep III., ...	94.48	4	0.6677	0.6390	9.29	17.40
	Sheep IV., ...	94.90	4	0.6520	0.6415	9.17	17.15
	Corn Cobs.						
VI.	Sheep I., ...	93.25	3	0.5940	0.5950	11.43	21.40
	Sheep II., ...	92.71	3	0.6057	0.6140	11.80	22.08
	Dried Brewers' Grains.						
VII.	Sheep I., ...	95.51	4	0.8705	0.8500	12.20	22.60
	Sheep II., ...	94.43	4	0.8756	0.8817	12.52	23.34
	Spring Wheat Bran.						
VIII.	Sheep II., ...	94.76	4	0.8573	0.8623	12.20	22.76
	Sheep III., ...	94.73	4	0.8240	0.8400	11.82	22.04
	Winter Wheat Bran.						
IX.	Sheep IV., ...	95.43	4	0.7810	0.7730	10.94	20.45

The data furnished in the above tables enable us to calculate the digestibility of the pentosans, as found in the tables following: —

DIGESTIBILITY OF PENTOSANS. — *Period I. English Hay.*

SHEEP II. Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.	**SHEEP III.** Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.	**SHEEP IV.** Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.
749 28 grams hay eaten,	152.93	754.12 grams hay eaten,	153.91	769.50 grams hay eaten,	157.05
294.67 grams manure excreted,	56.58	286.50 grams manure excreted,	54.20	296.78 grams manure excreted,	59.59
Grams pentosans digested,	96.35	Grams pentosans digested,	99.71	Grams pentosans digested,	97.46
Per cent. pentosans digested,	63.00	Per cent. pentosans digested,	64.80	Per cent. pentosans digested,	62.10
Average per cent. pentosans digested (three sheep),				63.30	

Period II. — Buffalo Gluten Feed.

SHEEP II. Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.	**SHEEP IV.** Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.
491.35 grams hay fed,	100.28	528.30 grams hay fed,	107.83
271.77 grams Buffalo gluten fed,	46.64	225.00 grams Buffalo gluten fed,	38.61
Total consumed,	146.92	Total consumed,	146 44
259.73 grams manure excreted,	48.73	247.77 grams manure excreted,	47.40
Grams digested,	98.19	Total digested,	99.04
Minus pentosans digested in hay,	63.18	Minus pentosans digested in hay,	66.96
Grams pentosans digested,	35.01	Grams pentosans digested,	32.08
Per cent. pentosans digested,	75.10	Per cent. pentosans digested,	83.10
Average per cent. pentosans digested (two sheep),		79.10	

Period III.—Hay (b).

Sheep I.		Sheep II.	
Daily Statement.—Dry Matter.	Pentosans in Food consumed and Manure excreted.	Daily Statement.—Dry Matter.	Pentosans in Food consumed and Manure excreted.
765.36 grams hay fed,	171.67	765.36 grams hay fed,	171.67
337.95 grams manure excreted,	63.91	343.62 grams manure excreted,	68.52
Grams pentosans digested,	107.76	Grams pentosans digested,	103.15
Per cent. pentosans digested,	62.70	Per cent. pentosans digested,	60.10

Sheep III.		Sheep IV.	
Daily Statement.—Dry Matter.	Pentosans in Food consumed and Manure excreted.	Daily Statement.—Dry Matter.	Pentosans in Food consumed and Manure excreted.
765.36 grams hay fed,	171.67	765.36 grams hay fed,	171.67
339.33 grams manure excreted,	64.40	337.83 grams manure excreted,	61.35
Grams pentosans digested,	107.27	Grams pentosans digested,	110.32
Per cent. pentosans digested,	62.50	Per cent. pentosans digested,	64.30
Average per cent. pentosans digested (four sheep),			62.40

Period IV. — New-process Linseed Meal.

SHEEP II. Daily Statement. — Dry Matter.	SHEEP II. Pentosans in Food consumed and Manure excreted.	SHEEP III. Daily Statement. — Dry Matter.	SHEEP III. Pentosans in Food consumed and Manure excreted.
526.38 grams hay fed,	118.07	526.38 grams hay fed,	118.07
220.70 grams new-process linseed meal fed,	29.79	220.70 grams new-process linseed meal fed,	29.79
Total consumed,	147.86	Total consumed,	147.86
280.76 grams manure excreted,	51.80	271.77 grams manure excreted,	46.12
Grams digested,	96.06	Grams digested,	101.74
Minus pentosans digested in hay,	70.96	Minus pentosans digested in hay,	73.78
Grams pentosans digested,	25.10	Grams pentosans digested,	27.96
Per cent. pentosans digested,	84.30	Per cent. pentosans digested,	93.90
Average per cent. pentosans digested (two sheep),			89.10

Period V. — Old-process Linseed Meal.

SHEEP II. Daily Statement. — Dry Matter.	SHEEP II. Pentosans in Food consumed and Manure excreted.	SHEEP III. Daily Statement. — Dry Matter.	SHEEP III. Pentosans in Food consumed and Manure excreted.	SHEEP IV. Daily Statement. — Dry Matter.	SHEEP IV. Pentosans in Food consumed and Manure excreted.
517.38 grams hay fed,	116.05	517.38 grams hay fed,	116.05	526.38 grams hay fed,	118 07
218.18 grams old-process linseed meal fed,	29.45	218.18 grams old-process linseed meal fed,	29.45	220.00 grams old-process linseed meal fed,	29 70
Total consumed,	145.50	Total consumed,	145.50	Total consumed,	147.77
285.76 grams manure excreted,	50.29	268.10 grams manure excreted,	46.65	280.20 grams manure excreted,	48 05
Total digested,	95.21	Total digested,	98.85	Total digested,	99.72
Minus pentosans digested in hay,	69 75	Minus pentosans digested in hay,	72.53	Minus pentosans digested in hay,	75 92
Grams pentosans digested,	25.46	Grams pentosans digested,	26.32	Grams pentosans digested,	23.80
Per cent. pentosans digested in hay,	86.40	Per cent. pentosans digested in hay,	89.40	Per cent pentosans digested in hay,	80.10
Average per cent. pentosans digested (three sheep),					85.30

Period VI. — Corn Cobs.

Sheep I. Daily Statement. — Dry Matter.	Sheep I. Pentosans in Food consumed and Manure excreted.	Sheep II. Daily Statement. — Dry Matter.	Sheep II. Pentosans in Food consumed and Manure excreted.
384.03 grams hay fed,	86.14	334.48 grams hay fed,	75.02
351.56 grams corn cobs fed,	110.17	351.56 grams corn cobs fed,	110.18
220.25 grams new-process linseed meal fed,	29.73	177.14 grams new-process linseed meal fed,	23.91
Total consumed,	226.05	Total consumed,	209.11
353.05 grams manure excreted,	75.55	331.73 grams manure excreted,	73.25
Total digested,	150.50	Total digested,	135.86
Minus pentosans in hay and linseed meal digested,	80.49	Minus pentosans in hay and linseed meal digested,	65.25
Grams pentosans digested,	70.01	Grams pentosans digested,	70.61
Per cent. pentosans digested,	63.50	Per cent. pentosans digested,	64.10
Average per cent. pentosans digested (two sheep),			63.80

Period VII. — Dried Brewers' Grains.

Sheep I. Daily Statement. — Dry Matter.	Sheep I. Pentosans in Food consumed and Manure excreted.	Sheep II. Daily Statement. — Dry Matter.	Sheep II. Pentosans in Food consumed and Manure excreted.
433.00 grams hay consumed,	97.12	433.00 grams hay consumed,	97.12
358.72 grams brewers' grain consumed,	88.14	358.72 grams brewers' grain consumed,	88.14
Total consumed,	185.26	Total consumed,	185.26
328.83 grams manure excreted,	74.32	331.87 grams manure excreted,	77.45
Total digested,	110.94	Total digested,	107.81
Minus pentosans in hay digested,	60.89	Minus pentosans in hay digested,	58.37
Grams pentosans digested,	50.05	Grams pentosans digested,	49.44
Per cent. pentosans digested,	56.80	Per cent. pentosans digested,	56.10
Average per cent. pentosans digested (two sheep),			56.40

Period VIII. — Spring Wheat Bran.

Sheep II.		Sheep III.	
Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.	Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.
523.44 grams hay fed,	117.41	523.44 grams hay fed,	117.41
261.93 grams spring bran fed,	76.14	261.93 grams spring bran fed,	76.14
Total fed,	193.55	Total fed,	193.55
333.84 grams manure excreted,	75.98	329.49 grams manure excreted,	72.62
Total digested,	117.57	Total digested,	120.93
Minus pentosans in hay digested,	70.56	Minus pentosans in hay digested,	73.38
Grams pentosans digested,	47.01	Grams pentosans digested,	47.55
Per cent. pentosans digested,	61.70	Per cent. pentosans digested,	62.50
Average per cent. pentosans digested (two sheep),			62.10

Period IX. — Winter Wheat Bran.

Sheep IV.	
Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.
517.38 grams hay consumed,	116.05
259.47 grams winter bran consumed,	63.90
Total consumed,	179 95
315.42 grams manure excreted,	64 50
Total digested,	115.45
Minus pentosans in hay digested,	74.61
Grams pentosans digested,	40.84
Per cent. pentosans digested,	63.90

RÉSUMÉ OF RESULTS.

Comparison of the digestibility of the pentosans with the digestibility of the other fodder constituents: —

KIND OF FOOD.	Dry Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).	Pentosans (Per Cent.).
Hay of mixed grasses (*a*),	61	64	51	63	63	63
Hay of mixed grasses (*b*),	56	57	47	57	58	62
Buffalo gluten feed, .	78	43	81	85	81	79
New-process linseed meal,	81	61	91	87	86	89
Old-process linseed meal,	79	57	89	89	78	85
Corn cobs, . . .	59	65	50	17	60	64
Dried brewers' grains, .	62	53	91	79	59	56
Spring wheat bran, .	63	24	76	80	70	62
Winter wheat bran, .	66	56	61	79	70	64

The above figures show that the pentosans in six out of nine cases are practically as digestible as any of the other groups of fodder substances.

In both samples of hay the pentosans are fully as digestible as either the cellulose or protein. In case of the dried brewers' grains and the two brans the fat and protein are noticeably more digestible than the pentosans.

With the more concentrated foods it will be observed that the pentosans are as digestible as either the fat, protein or extract matter. *The results make clear that association has a great deal to do with digestibility.* In the hays, corn cobs and brewers' grains, where the woody substance (lignin) is present to a considerable extent, the digestibility of the pentosans is noticeably less than when the incrusting substance is absent. Whether or not the pentosans are chemically united to the incrusting substances is not known, but it is not at all improbable. It is certainly clear that the incrusting substances perceptibly interfere with the digestibility of the xylan or araban. This has also been proved to be the case with cellulose, first indirectly by Henneberg and Stohmann * and later directly by F. Lehmann,† who found that when the fibre was freed from all incrusting substances the cellulose was practically all digestible.

Stone has already shown, in case of hays, bran and such fodders, that the pentosans have an average digestibility of 60 per cent., and our results with similar fodders simply confirm his investigations. With the more concentrated feeds, where little incrusting substance is present, the pentosans are as digestible as any other of the fodder groups. One might assume that if the pentosans were isolated and fed to animals they would be fully as digestible as starch or pure cellulose.

While from 60 to 90 per cent. of the pentosans in the present experiment have been removed from the digestive tract in the process of digestion, it has certainly not been demonstrated that they have been assimilated and have a food value equal to that of starch and similar substances. In case of human beings Ebstein has already proved to the contrary. We hope to be able to throw additional light upon this point in the near future.

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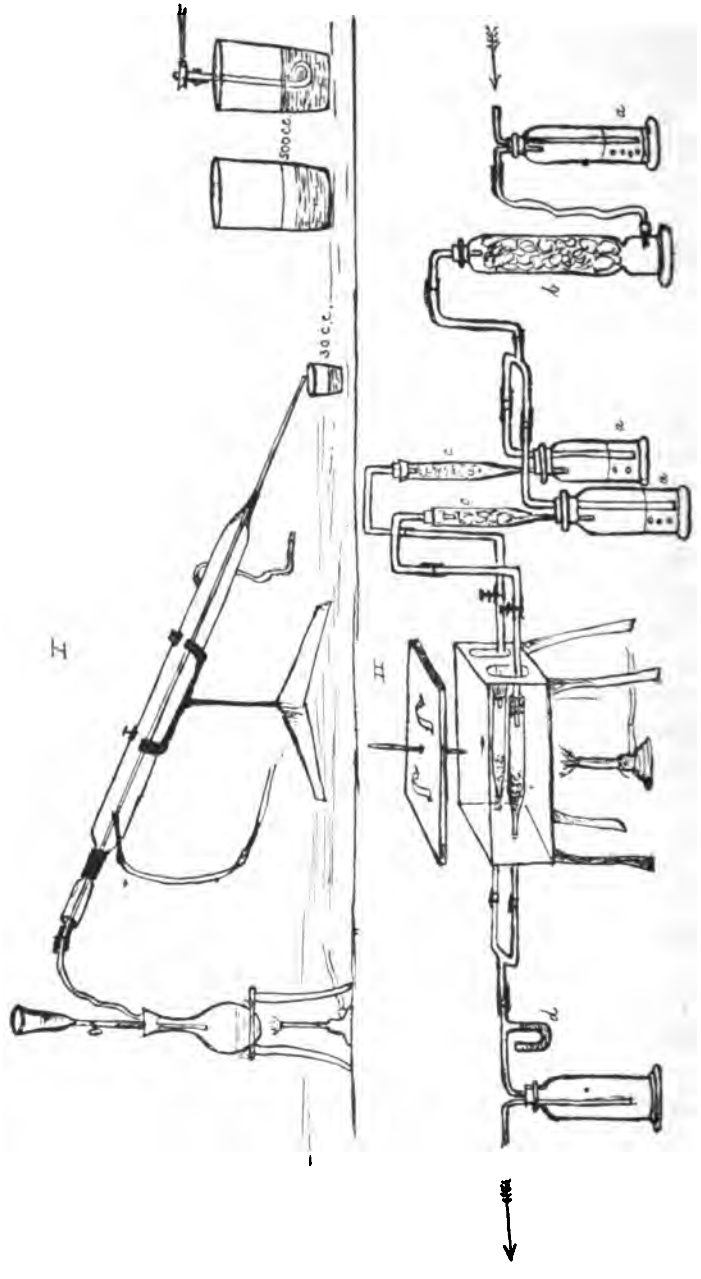
* Futterung der Wiederkauer, 1860.

† Journal f. Landw. 48, 435.



I. Distillation Apparatus.
II. Drying Apparatus.

a. Sulphuric Acid.
b. Pumice Stone moistened with Sulphuric Acid.

c. Crushed Marble.
d. Filled with Mercury to show Vacuum.

PART II.

FIELD EXPERIMENTS.

C. A. GOESSMANN.

1. FIELD EXPERIMENTS FOR THE PURPOSE OF STUDYING THE ECONOMY OF RAISING LEGUMINOUS CROPS (CLOVER-LIKE PLANTS) AS A MEANS OF ENRICHING THE SOIL IN NITROGEN IN THE INTEREST OF THE SUBSEQUENT RAISING OF GRAIN CROPS (FIELD A).
2. FIELD EXPERIMENTS WITH SEVERAL PROMINENT VARIETIES OF POTATOES AND SOME PROMINENT MIXED FORAGE CROPS (VETCH, OATS AND HORSE BEAN, VETCH AND OATS AND VETCH AND BARLEY) (FIELD B).
3. FIELD EXPERIMENTS TO ASCERTAIN THE INFLUENCE OF DIFFERENT MIXTURES OF COMMERCIAL FERTILIZERS ON THE YIELD AND GENERAL CHARACTER OF SEVERAL PROMINENT GARDEN CROPS (FIELD C).
4. EXPERIMENTS WITH FORAGE CROPS (FIELD D), ILLUSTRATED WITH CUTS OF ROOTS OF FOUR PROMINENT LEGUMINOUS CROPS (VETCH, SOJA BEAN, LUPINE AND HORSE BEAN).
5. TRIAL OF AN EARLY MATURING VARIETY OF MINNESOTA DENT CORN, HURON (FIELD E).
6. FIELD EXPERIMENTS WITH DIFFERENT COMMERCIAL PHOSPHATES, TO STUDY THE ECONOMY OF USING THE CHEAPER NATURAL PHOSPHATES OR THE MORE COSTLY ACIDULATED PHOSPHATES (FIELD F).
7. EXPERIMENTS WITH FORAGE CROPS (VETCH AND OATS AND HUNGARIAN GRASS) (FIELD G).
8. FIELD EXPERIMENTS TO STUDY THE EFFECT OF PHOSPHATIC SLAG AND NITRATE OF SODA, AS COMPARED WITH GROUND BONE, ON THE YIELD OF OATS AND CORN (EAST FIELD).
9. EXPERIMENTS WITH PERMANENT GRASS LANDS (MEADOWS) (EAST FIELD).
10. ORCHARD EXPERIMENTS WITH HOME-MADE STABLE MANURE, UNLEACHED WOOD ASHES AND SEVERAL MIXTURES OF FERTILIZING MATERIALS ON THE GROWTH AND YIELD OF SEVERAL VARIETIES OF FRUIT TREES.
11. OBSERVATIONS IN VEGETATION HOUSE.
12. REPORT ON GENERAL FARM WORK.

1. FIELD EXPERIMENTS FOR THE PURPOSE OF STUDYING THE ECONOMY OF RAISING LEGUMINOUS CROPS (CLOVERS, ETC.) AS A MEANS OF ENRICHING THE SOIL IN NITROGEN IN THE INTEREST OF THE SUBSEQUENT RAISING OF GRAIN CROPS.

Field A.

The systematic treatment of the field here under consideration, as far as suitable modes of cultivation and of manuring are concerned, was introduced during the season of 1883–84. The subdivision of the entire area into eleven plats (one-tenth of an acre each) of a uniform size and shape, one hundred and thirty-two feet long and thirty-three feet wide, with an unoccupied and unmanured space of five feet in width between adjoining plats, has been retained unaltered since 1884. A detailed statement of the particular aim and general management of our experiments, as well as of the results obtained in that connection from year to year, forms a prominent part of our contemporary printed annual reports, to which I have to refer for details.

Since 1889 the main object of observations upon the same field has been to study the influence of an entire exclusion of any additional nitrogen-containing manurial substance from the soil under cultivation, as well as of a definite additional supply of nitrogen in different forms of combination, on the character and yield of the crop selected for the trial.

Several plats which for five preceding years did not receive any nitrogen compound for manurial purposes were retained in that state, to study the effect of an entire exclusion of nitrogen-containing manurial substances on the crop under cultivation, while the remaining ones received, as before, a definite amount of nitrogen in the same form in which they had received it in preceding years; namely, either as sodium nitrate or as ammonium sulphate, or as organic nitrogenous matter in form of dried blood or of barn-yard manure. A corresponding amount of available nitrogen was applied in all these cases.

Amount of Fertilizing Ingredients used Annually per Acre.

Plats 0, 1, 2, 3, 5, 6, 8, 10,	Nitrogen,	45 pounds.
	Phosphoric acid,	80 pounds.
	Potassium oxide,	125 pounds.
Plats 4, 7, 9,	Nitrogen,	none.
	Phosphoric acid,	80 pounds.
	Potassium oxide,	125 pounds.

One plat, marked 0, received its main supply of phosphoric acid, potassium oxide and nitrogen in form of barn-yard manure; the latter was carefully analyzed before being applied, to determine the amount required to secure, as far as practicable, the desired corresponding proportion of the three essential fertilizing constituents. The deficiency in potassium oxide and phosphoric acid was supplied by potash-magnesia sulphate and dissolved bone-black. The fertilizer for this plat consisted of 800 pounds of barn-yard manure, 32 pounds of potash-magnesia sulphate and 18 pounds of dissolved bone-black.

The mechanical preparation of the soil, the incorporation of the manurial substances, — the general character of the latter being the same, — the seeding, cultivating and harvesting were carried on year after year in a like manner and as far as practicable on the same day in case of every plat during the same year.

The subsequent tabular statement shows the annual application and special distribution of the manurial substances with reference to each plat since 1889. The fertilizers were in every case applied broadcast as early in the spring as circumstances permitted. They were well harrowed under before the seed was planted in rows by a seed drill.

PLATS.	Annual Supply of Manurial Substances.
Plat 0,	800 lbs. of barn-yard manure, 32 lbs. of potash-magnesia sulphate and 18 lbs. of dissolved bone-black.
Plat 1, .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 2, .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 3, .	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 4, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 5, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 6, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 7, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 8, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 9, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 10, .	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).

Cost of Fertilizers applied to Field A.

	Cost per Plat.	Cost per Acre.
Plat 0, ...	$2 28	$22 75
Plat 1, ...	1 99	19 90
Plat 2, ...	2 43	24 30
Plat 3, ...	2 09	20 90
Plat 4, ...	1 23	12 30
Plat 5, ...	2 46	24 58
Plat 6, ...	2 02	20 18
Plat 7, ...	1 23	12 30
Plat 8, ...	2 02	20 18
Plat 9, ...	1 23	12 30
Plat 10, ...	2 53	25 30

The above-described course of the general management of the experiment has been followed thus far for five consecutive years (1889–93, inclusive).

Kind of Crops raised.

Corn (maize),	in 1889.
Oats,	in 1890.
Rye,	in 1891.
Soja bean,	in 1892.
Oats,	in 1893.

The annual yield of the various crops upon the different plats showed that as a rule those plats (4, 7, 9) which had not received in any form nitrogen for manurial purposes yielded much smaller crops than those that received annually in some form or other an addition of a corresponding amount of available nitrogen.

The results of our observations were stated as follows: —

The experiments carried on upon Field A during the years 1889, '90, '91 and '92 show conclusively the importance of a liberal supply to the soil of an available form of nitrogen, to secure a successful and remunerative cultivation of farm crops under otherwise corresponding favorable conditions. For even a leguminous crop, the soja bean, when for the first time raised upon Field A, did not furnish an exception to our observation (1892).

1893. — The main object of our experiment upon Field A during that season was to observe the after-effect of the cultivation of soja bean (a leguminous crop) on the nitrogen resources of the soil which served for its production. It seemed of interest in our case to ascertain whether the raising of the soja bean upon Field A had increased the amount of available nitrogen stored up in the soil to such an extent as to affect the yield of the succeeding crop upon those plats (4, 7, 9) which as a rule did not receive at any time an addition of available nitrogen from any other manurial source but the atmospheric air and the roots of the soja beans left in the soil after harvesting the crop.

A grain crop (oats) was selected as the crop suitable to serve for that purpose. The general management of the experiment, as far as the preparation of the soil, manuring and seeding-down are concerned, was the same as in preceding years (see tenth annual report).

Yield of Oat Crop on Different Plats (1893).

[Pounds.]

	Weight of Oats.	Weight of Oats per Acre.	Weight of Straw and Chaff.	Weight of Grain.	Weight of Straw and Chaff per Acre.	Weight of Grain per Acre.
Plat 0, . . .	530	5,300	399	131	3,990	1,310
Plat 1, . . .	690	6,900	555	135	5,550	1,350
Plat 2, . . .	600	6,000	454	146	4,540	1,460
Plat 3, . . .	700	7,000	534	166	5,340	1,660
Plat 4, . . .	590	5,900	430	160	4,300	1,600
Plat 5, . . .	630	6,300	551	79	5,510	790
Plat 6, . . .	600	6,000	498	102	4,980	1,020
Plat 7, . . .	550	5,500	431	119	4,310	1,190
Plat 8, . . .	420	4,200	325	95	3,250	950
Plat 9, . . .	480	4,800	370	110	3,700	1,100
Plat 10, . . .	610	6,100	485	125	4,850	1,250

Ratio of Grain to Straw.

Plat 0, ...	1:3	Plat 6, ...	1:4.9
Plat 1, ...	1:4.1	Plat 7, ...	1:3.6
Plat 2, ...	1:3.1	Plat 8, ...	1:3.4
Plat 3, ...	1:3.2	Plat 9, ...	1:3.4
Plat 4, ...	1:2.7	Plat 10, ...	1:3.9
Plat 5, ...	1:7		

Conclusions. — An examination of the results given above shows that the total crop per acre on those plats to which no nitrogen was applied (4, 7 and 9) averaged 800 pounds less than in case of the plats which received their regular supply of nitrogen in some form or other.

Plat 8 shows again the exceptional conditions of previous years, for, although fertilized in a like manner as Plat 6, its total yield was 1,800 pounds less.

In yield of grain those plats which received their nitrogen in the form of sulphate of ammonia (5, 6 and 8) averaged 92 pounds; those in the form of organic nitrogen (0, 6 and 8), 140⅜ pounds; those in the form of nitrate of soda (1 and 2), 140½ pounds.

The best results in relation of total yield to yield of grain were obtained in the case of those plats receiving organic nitrogen (dried blood and barn-yard manure), or nitrogen in the form of nitrate of soda; while in the case of sulphate of ammonia the ratio of grain to straw was too wide to give the best satisfaction.

The total yield of crops on the plats receiving no nitrogen addition, as compared with those receiving a nitrogen supply, was during the succeeding years as follows: —

With oats in 1890, one-fifth to one-sixth less;
With rye in 1891, one-fifth to one-sixth less;
With soja bean in 1892, one-third to one-fourth less; and
With oats in 1893, one-seventh to one-eighth less.

From this it will appear that the introduction of a leguminous crop into our rotation had somewhat reduced the difference in yield between the plats receiving no nitrogen and those receiving it, yet had not entirely obliterated it.

It was decided to continue the observation by repeating the raising of soja beans in 1894 and oats in 1895.

1894. — To secure, if possible, more decisive results regarding the presence and absence of nitrogen, it was decided to use twice the amount of phosphoric acid and potassium oxide, as compared with preceding years.

Amount of Fertilizing Ingredients applied per Acre during 1894.

Plats 0, 1, 2, 3, 5, 6, 8, 10,	Nitrogen,	45 pounds.
	Phosphoric acid,	160 pounds.
	Potassium oxide,	250 pounds.
Plats 4, 7, 9,	Nitrogen,	none.
	Phosphoric acid,	160 pounds.
	Potassium oxide,	250 pounds.

PLATS.	Manurial Substances Applied.
Plat 0, .	800 lbs. barn-yard manure, 80½ lbs. potash-magnesia sulphate and 77 lbs. dissolved bone-black.
Plat 1, .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 2, .	29 lbs. nitrate of soda (= 4 to 5 lbs. nitrogen), 97 lbs. potash-magnesia sulphate (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 3, .	43 pounds dried blood (= 5 to 6 lbs. nitrogen), 54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 4, .	54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 5, .	22½ lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 97 lbs. potash-magnesia sulphate (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 6, .	22½ lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 7, .	54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 8, .	22½ lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 9, .	54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 10, .	43 lbs. dried blood (= 4 to 5 lbs. nitrogen), 97 lbs. sulphate of potash-magnesia (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).

An early maturing variety of white soja bean was the crop employed for the experiment. The field was ploughed April 18, the barn-yard manure having been previously applied to Plat 0, and a quantity of lime to Plat 8.* Plats 1–10 received their fertilizer mixtures applied broadcast on May 10. After proper preparation of the soil the soja beans were planted on May 12 in drills two and one-half feet apart, six pounds of seed being used per plat. The plants appeared above ground May 21. June 5 the field was cultivated and hoed, and also on the 16th and 25th and July 12.

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* This plat had suffered for years, as noted in previous reports, from a serious attack of parasitic growth affecting the yield of the crop, and the lime was added to correct the condition of the soil and prevent, if possible, the return of the failure. The purpose for which it was applied was evidently served, for the yield of the crop was very satisfactory.

Height of Soja-bean Plants upon the Different Plats of Field A during the Season (1894).

[Inches.]

	July 3.	July 10.	July 24.
Plat 0,	12	16	24
Plat 1,	12	16	25
Plat 2,	12	19	26
Plat 3,	11	15	26
Plat 4,	11	14	25
Plat 5,	13	17	25
Plat 6,	11	16	26
Plat 7,	10	14	24
Plat 8,	12	15	27
Plat 9,	10	14	25
Plat 10,	11	16	26

The color of the crop varied somewhat on the different plats. Those receiving no nitrogen addition had a yellowish appearance throughout the season, while No. 8, which in previous years had been of inferior growth and color, appeared to do as well as any during the entire growing period. The plants began to bloom July 25. Owing to the protracted drought of July and August the crop did not get that fulness of growth which might have been obtained under more favorable conditions. The crop was cut August 28, being put into a silo with corn for the production of a mixed silage.

Yield of Soja Bean on Different Plats (1894).

[Pounds.]

	Per Plat.	Per Acre.
Plat 0,	600	6,000
Plat 1,	625	6,250
Plat 2,	700	7,000
Plat 3,	525	5,250
Plat 4,	405	4,050
Plat 5,	645	6,450
Plat 6,	615	6,150
Plat 7,	480	4,800
Plat 8,	680	6,800
Plat 9,	470	4,700
Plat 10,	570	5,700

Conclusions.

1. A comparison of the above-stated yield of the different plats shows that those plats (4, 7 and 9) which received no nitrogen addition from an outside source yielded on an average from 1,400 to 1,500 pounds less per acre than those receiving a nitrogen addition.

2. From these figures it appears that the increased cost of the fertilizer in the case of the plats receiving nitrogen (45 pounds nitrogen at 13 cents = $6.75) exceeds the value of the increase in crop produced by its application (allowing $5 per ton of green material containing 34.02 per cent. dry matter).

3. An increase of twice the amount of the phosphoric acid and potassium oxide as compared with earlier years (see report for 1892) has not affected the relative yield of the crop.

Analysis of Early Maturing Soja Bean.

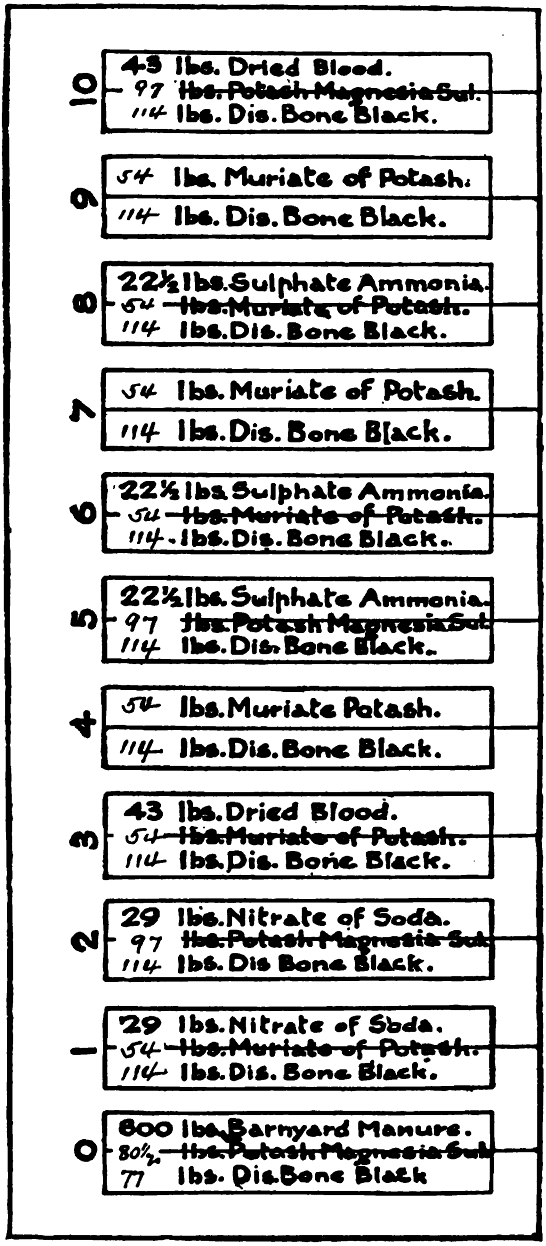
[Raised on Field A; collected when crop was cut, Aug. 28, 1894.]

	Per Cent.
Moisture at 100° C.,	65.98
Dry matter,	34.02
	100.00

Analysis of Dry Matter.

Crude ash,	9.69
" fibre,	17.28
" fat,	2.96
" protein,	20.13
Nitrogen-free extract matter,	49.94
	100.00

Field "A," 1894.


10
43 lbs. Dried Blood.
97 ~~lbs. Potash Magnesia Sul.~~
114 lbs. Dis. Bone Black.
9
54 lbs. Muriate of Potash.
114 lbs. Dis. Bone Black.
8
22½ lbs. Sulphate Ammonia.
54 ~~lbs. Muriate of Potash.~~
114 lbs. Dis. Bone Black.
7
54 lbs. Muriate of Potash.
114 lbs. Dis. Bone Black.
6
22½ lbs. Sulphate Ammonia.
54 ~~lbs. Muriate of Potash.~~
114 lbs. Dis. Bone Black.
5
22½ lbs. Sulphate Ammonia.
97 ~~lbs. Potash Magnesia Sul.~~
114 lbs. Dis. Bone Black.
4
54 lbs. Muriate Potash.
114 lbs. Dis. Bone Black.
3
43 lbs. Dried Blood.
54 ~~lbs. Muriate of Potash.~~
114 lbs. Dis. Bone Black.
2
29 lbs. Nitrate of Soda.
97 ~~lbs. Potash Magnesia Sul.~~
114 lbs. Dis Bone Black.
1
29 lbs. Nitrate of Soda.
54 ~~lbs. Muriate of Potash.~~
114 lbs. Dis. Bone Black.
0
800 lbs. Barnyard Manure.
80½ ~~lbs. Potash Magnesia Sul.~~
77 lbs. Dis. Bone Black

SCALE, 4 RODS TO 1 INCH.

2. Field Experiments with Several Varieties of Potatoes and Some Prominent Mixed Forage Crops.

Field B.

[*a*. Potatoes: Beauty of Hebron, Clark's and New Queen; *b*. Mixed forage crops: vetch, oats and horse bean, vetch and oats and vetch and barley.]

This field occupies an area of one and seven-tenths acres, and runs from north to south, nearly on a level. The soil consists of a somewhat sandy loam of several feet in depth. The systematic treatment of the area was inaugurated in 1884, when the present subdivision into eleven plats was first introduced. The plats are 175 feet long and 33 feet wide (5,775 square feet, or two-fifteenths of an acre), of a uniform shape, running from east to west, with a space of five feet between adjoining plats. The numbering begins at the north end with 11, and closes at the south end with 21.

For details regarding the work carried on upon Field B previous to 1892, see tenth annual report.

The character of the crops raised during 1892 may be noticed from the subsequent tabular statement: —

Crops raised in 1892.

Plats.	1892.	Yield of Hay, First and Second Cut (Pounds).	Rate per Acre (Pounds).
Plat 11,	Kentucky blue-grass, sown Sept. 24, 1889, . . .	335	2,513
Plat 12,	Kentucky blue-grass and red top, sown Sept. 18, 1891,	365	2,737
Plat 13,	English rye-grass and Italian rye-grass, sown Sept. 29, 1890.	255	1,913
Plat 14,	English rye-grass and red top, sown Sept. 29, 1890, .	225	1,688
Plat 15,	Herds grass and red top, sown April 23, 1891, . .	565	4,238
Plat 16,	Italian rye-grass and red top, sown April 23, 1891, .	565	4,238
Plat 17,	Meadow fescue, sown Sept. 25, 1887, ...	475	3,563
Plat 18,	Meadow fescue, sown Sept. 29, 1890, ...	490	3,675
Plat 19,	Herds grass, sown Sept. 25, 1889, ...	610	4,575
Plat 20,	Herds grass and red top, sown Sept. 29, 1890, . .	285	2,138
Plat 21,	Meadow fescue and herds grass, sown Sept. 18, 1891,	355	2,663
	Total, ...	4,525	-

At the close of the season (1892) it was decided to raise hereafter other crops than grasses upon plats 11, 13, 14, 15, 16 and 20. For this reason they were ploughed after the rowen had been secured, while plats 12, 17, 18, 19 and 21 remained in grass for another season.

1893.—Plats 11, 13, 14, 15, 16 and 20, which had been used for several preceding years for the production of grasses, were at an early date prepared to serve for experiments with several prominent varieties of potatoes. They were ploughed in August, 1892, and were again ploughed for the final preparation April 25, 1893.

It was proposed to compare the yield, as far as quantity and quality are concerned, under otherwise corresponding circumstances. Three varieties of potatoes, Beauty of Hebron, Clark's, New Queen, were chosen for the trial. The seed potatoes were obtained of J. J. H. Gregory & Son, Marblehead.

Two plats, 15 and 16, were assigned for the cultivation of Beauty of Hebron; two, 13 and 14, for that of New Queen; and two, 11 and 20, for that of Clark's variety.

One plat in each case received its potash supply in form of muriate of potash (plats 11, 13 and 15), and one in each case in that of high-grade sulphate of potash (plats 14, 16, 20).

The actual amount of potassium oxide used in all cases remained the same.

Statement of Fertilizers used (Pounds).

		Per Plat.	Per Acre.
Plats 11, 13, 15,	Muriate of potash,	54	400
	Bone,	80	600
Plats 14, 16, 20,	Sulphate of potash (high grade),	54	400
	Bone,	80	600

Composition of Fertilizers used.

[Per Cent.]

	Nitrogen.	Potash.	Phosphoric Acid.
Fine-ground bone, ...	4.02	-	22.96
Sulphate of potash, ...	-	50.20	-
Muriate of potash, ...	-	46.00	-

Market Cost of Fertilizers.

	Per Plat.	Per Acre.
Plats 11, 13, 15, ...	$2 39	$17 93
Plats 14, 16, 20, ...	2 66	19 95

The final mechanical preparation of the different plats was the same in all cases. The fertilizer was applied broadcast, and subsequently thoroughly harrowed in before planting. The potatoes were planted May 10 on all plats at the rate of nineteen bushels per acre, or two and one-half bushels potatoes per plat. Potatoes used were either whole ones of medium size, or when larger were cut in pieces of sizes corresponding to the former. Plats 11 and 20 were planted with Clark's variety; plats 13 and 14 were planted with New Queen variety; plats 15 and 16 were planted with Beauty of Hebron variety.

The crop began to break ground May 26, and was subsequently cultivated and hoed June 5 and June 20. The potatoes were in bloom June 24, and the tops began to die August 14. The crop was harvested August 23 and 24.

The potatoes were in all cases of a superior appearance; only one-eighth to one-ninth of the entire crop was not marketable as a first-class article, on account of small size.

YIELD OF CROP.

A. Potash applied in the Form of Muriate.

Yield of Potatoes in Pounds.

VARIETY.	AMOUNT PER PLAT.			RATE PER ACRE.		
	Marketable.	Small.	Total.	Marketable.	Small.	Total.
Plat 11, Clark's, . .	1,450	225	1,675	10,875	1,688	12,563
Plat 13, New Queen,. .	1,620	240	1,860	12,150	1,800	13,950
Plat 15, Beauty of Hebron,	2,160	190	2,350	16,200	1,425	17,625

Yield of Potatoes in Bushels (60 Pounds per Bushel).

Plat 11, Clark's, . .	-	-	-	181	28	209
Plat 13, New Queen,. .	-	-	-	203	30	233
Plat 15, Beauty of Hebron,	-	-	-	270	24	294

B. Potash applied in the Form of High-grade Sulphate.

Yield of Potatoes in Pounds.

VARIETY.	AMOUNT PER PLAT.			RATE PER ACRE.		
	Marketable.	Small.	Total.	Marketable.	Small.	Total.
Plat 20, Clark's, . .	1,540	230	1,770	11,550	1,725	13,275
Plat 14, New Queen,. .	1,860	190	2,050	13,950	1,425	15,375
Plat 16, Beauty of Hebron,	2,190	240	2,430	16,425	1,800	18,225

Yield of Potatoes in Bushels (60 Pounds per Bushel).

Plat 20, Clark's, . .	-	-	-	193	29	222
Plat 14, New Queen,. .	-	-	-	233	24	257
Plat 16, Beauty of Hebron,	-	-	-	274	30	304

From an examination of the above tabular statement of the yield of the different varieties of potatoes on trial we arrived at the following conclusions: —

1. The yield of potatoes is in every instance larger in case sulphate of potash has furnished the potash of the fertilizer used than where muriate of potash has served for that purpose.

2. The yield of the three varieties of potatoes on trial, although raised under a corresponding system of cultivation and of manuring, differs seriously. Beauty of Hebron produces nearly one-sixth more in weight than the New Queen variety, and one-third more than the Clark variety.

Plats 12, 17, 18, 19 and 21, which remained in grass in previous years, received as top-dressing, muriate of potash, 200 pounds, and ground bone, 600 pounds, per acre, at an early date in the spring, 1893. The grass was cut June 27 and 28. As the weeds began to infest the plats, the experiment of studying a variety of grasses was closed, and the sod turned under during the month of August. Dry lands do not favor for any length of time an economical and clean cultivation of the majority of our best grasses. For details, see eleventh annual report for 1893.

A. Observations with Potatoes (1894).

During the present season the experiments of the preceding year with potatoes were repeated, and several varieties of mixed forage crops substituted for the grasses. Beauty of Hebron, Clark's and New Queen were the varieties of potatoes used in the trial, the seed tubers being selected from our crop of the previous year. Beauty of Hebron were grown on plats 12 and 21, New Queen on 17 and 18, and Clark's on 19 and 20. One plat in each case was supplied with potash in the form of muriate of potash (17, 19 and 21), and one in each case in the form of high-grade sulphate of potash (12, 18 and 20).

Fertilizer used.

[Pounds.]

		Per Plat.	Per Acre.
Plats 12, 18, 20,	Sulphate of potash (high grade), .	54	400
	Bone, ...	80	600
Plats 17, 19, 21,	Muriate of potash, ...	54	400
	Bone, ...	80	600

Composition of Fertilizer used.

	Nitrogen.	Potash.	Phosphoric Acid.
Fine-ground bone, ...	4.09	-	21.86
Sulphate of potash, ...	-	50.80	-
Muriate of potash, ...	-	52.20	-

Market Cost of Fertilizers.

	Per Plat.	Per Acre.
Plats 12, 18, 20, ...	$2 39	$17 80
Plats 17, 19, 21, ...	2 12	15 80

The field was ploughed April 11, the fertilizer was applied broadcast April 20, and harrowed in. The potatoes were planted April 24, at the rate of two and one-half bushels per plat, or nineteen bushels per acre. As far as possible medium-sized whole potatoes were used for seed, and when larger ones were used they were cut in pieces corresponding in size to the former. May 11 the crop began to appear above ground, but was somewhat nipped by the frost of the 15th. The field was cultivated and hoed May 30 and June 18, on which latter date the first appearance of blooming was noticed on the various plats, Beauty of Hebron leading. Owing to the severe drought during the latter part of the growing period, the crop did not turn out as good as at first indicated, there being a serious falling off in yield and an unusually large proportion of small tubers.

YIELD OF CROP (1894).

A. Potash applied in the Form of Muriate.

Yield of Potatoes in Pounds.

VARIETY.	AMOUNT PER PLAT.			RATE PER ACRE.		
	Marketable.	Small.	Total.	Marketable.	Small.	Total.
Plat 19, Clark's, . . .	870	539	1,409	6,660	4,064	10,724
Plat 17, New Queen, . .	1,161	563	1,724	8,754	4,245	12,999
Plat 21, Beauty of Hebron, .	962	449	1,411	7,253	3,384	10,637

Yield of Potatoes in Bushels (60 Pounds per Bushel).

Plat 19, Clark's, . . .	–	–	–	111	67	178
Plat 17, New Queen, . .	–	–	–	146	70	216
Plat 21, Beauty of Hebron, .	–	–	–	121	56	177

B. Potash applied in the Form of High-grade Sulphate.

Yield of Potatoes in Pounds.

VARIETY.	AMOUNT PER PLAT.			RATE PER ACRE.		
	Marketable.	Small.	Total.	Marketable.	Small.	Total.
Plat 20, Clark's, . . .	741	527	1,268	5,587	3,973	9,560
Plat 18, New Queen, . .	1,183	510	1,693	8,920	3,845	12,765
Plat 12, Beauty of Hebron, .	1,230	511	1,741	9,274	3,853	13,127

Yield of Potatoes in Bushels (60 Pounds per Bushel).

Plat 20, Clark's, . . .	–	–	–	93	66	159
Plat 18, New Queen, . .	–	–	–	149	64	213
Plat 12, Beauty of Hebron, .	–	–	–	154	64	218

Comparison of Yield for 1893 and 1894.

Total Yield (Bushels per Acre).

	1893.	1894.	Percentage of Decrease.
Clark's, with muriate of potash, . .	209	178	14.84
New Queen, with muriate of potash, .	233	216	7.30
Beauty of Hebron, with muriate of potash,	294	177	19.80
Clark's, with sulphate of potash, . .	222	159	28.38
New Queen, with sulphate of potash, .	257	213	17.12
Beauty of Hebron, with sulphate of potash,	304	218	27.60

Percentage of Marketable Potatoes.

Clark's, with muriate of potash, . .	86.60	62.36	24.24
New Queen, with muriate of potash, .	87.12	67.59	19.53
Beauty of Hebron, with muriate of potash,	91.83	68.36	23.47
Clark's, with sulphate of potash, . .	86.92	58.49	28.43
New Queen, with sulphate of potash, .	90.66	70.00	20.66
Beauty of Hebron, with sulphate of potash,	90.13	70.64	19.49

The crop of 1894 as compared with that of 1893 is in every case smaller, owing to the exceptionally dry season.

The relative proportion of marketable tubers is considerably greater in 1893 than in 1894, owing to a premature cessation of growth during the drought.

The difference in yield of the plats receiving muriate, as compared with those receiving high-grade sulphate of potash, is but slight.

The severe drought has affected results to such an extent that no further conclusions can be drawn with reference to the fertilizer used.

B. Observations with Mixed Forage Crops (1894).

Plats 11, 13, 14, 15 and 16, which were used for the production of potatoes during 1893, were set apart for the raising of mixed forage crops during 1894. Plats 11, 13 and 15 were fertilized at the rate of 400 pounds of muriate of potash and 600 pounds of ground bone per acre, while plats 14 and 16 were fertilized with 400 pounds of high-grade sulphate of potash and 600 pounds ground bone. Vetch, oats and horse bean were raised on Plat 11, vetch and barley on plats 13 and 14 and vetch and oats on plats 15 and 16. The plats were prepared for planting at the same time and in a similar manner as those used for the raising of potatoes.

Vetch and Barley. — Plats 13 and 14 were prepared for the raising of vetch and barley. Plat 13 was fertilized with muriate of potash and bone and Plat 14 with sulphate of potash and bone. The seed was sown April 26, at the rate of 45 pounds vetch and 3 bushels barley per acre. The plants appeared above ground May 4.

Height of Plants on Plats.

[Inches.]

	Plat 13 (Muriate).	Plat 14 (Sulphate).
June 12,	20	20
June 18,	28	28

The barley began to head out June 20, and June 23 the crop was cut for hay, the vetch being just in bloom. The yield of hay was as follows: —

	Per Plat (Pounds).	Per Acre (Pounds).
Plat 13,.	765	5,737
Plat 14,.	677	5,077

Analyses of Vetch and Barley.

[Equal number of plants of each; collected June 22, 1894.]

	Per Cent.	
	Plat 13.	Plat 14.
Moisture at 100° C.,	78.23	77.70
Dry matter,	21.77	22.30
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	4.64	7.80
" fibre,	32.25	32.58
" fat,	2.12	2.56
" protein,	14.44	13.36
Nitrogen-free extract matter,	46.55	43.70
	100.00	100.00

Vetch and Oats. — Plats 15 and 16 were set aside for the raising of vetch and oats. Plat 15 was fertilized with 400 pounds muriate of potash and 600 pounds ground bone per acre, and Plat 16 with 400 pounds of high-grade sulphate of potash and 600 pounds ground bone. The land was prepared as for the other plats. The seed was put in April 6, at the rate of 45 pounds vetch and 4 bushels of oats per acre. May 4 the plants appeared above ground.

Height of Plants on Plats.

[Inches.]

	Plat 15 (Muriate).	Plat 16 (Sulphate).
June 12,	20	20
June 18,	26	24
June 26,	33	33

The oats began to head out June 25, and the crop was cut for hay July 2, the vetch being then on the point of blooming. The yield of hay was as follows: —

	Pounds.	
	Per Plat.	Per Acre.
Plat 15,	1,068	8,051
Plat 16,	940	7,088

Analyses of Vetch and Oats.

[Equal number of plants of each; collected July 5, 1894.]

	Per Cent.	
	Plat 15.	Plat 16.
Moisture at 100° C.,	76.24	75.29
Dry matter,	23.76	24.71
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	9.59	8.69
" fibre,	29.83	31.28
" fat,	3.13	2.63
" protein,	18.88	15.16
Nitrogen-free extract matter,	38.57	42.24
	100.00	100.00

Vetch, Oats and Horse Bean. — Plat 11, which was used for growing the above crop, was fertilized at the rate of 400 pounds of muriate of potash and 600 pounds of ground bone per acre, the preparation of the plat for the seed being the same as for the other plats. May 8 the seed was sown, at the rate of 60 pounds vetch, 60 pounds horse bean and 136 pounds of oats per acre. On May 16 the vetch and oat plants were coming up, and the horse bean appeared on the 21st.

Height of Plants.

[Inches.]

June 18,	15
June 26,	22

June 28 the horse-bean plants began to bloom, and July 2 the crop was cut. The plat yielded 835 pounds of hay, at the rate of 6,294 pounds per acre.

Analysis of Vetch, Oats and Horse Bean.

[Three plants each of vetch and of oats and one of horse bean; collected July 9, 1894.]

	Per Cent.
Moisture at 100° C.,	82.13
Dry matter,	17.87
	100.00

Analysis of Dry Matter.

Crude ash,	10.36
" fibre,	30.07
" fat,	2.70
" protein,	18.93
Nitrogen-free extract matter,	77.94
	100.00

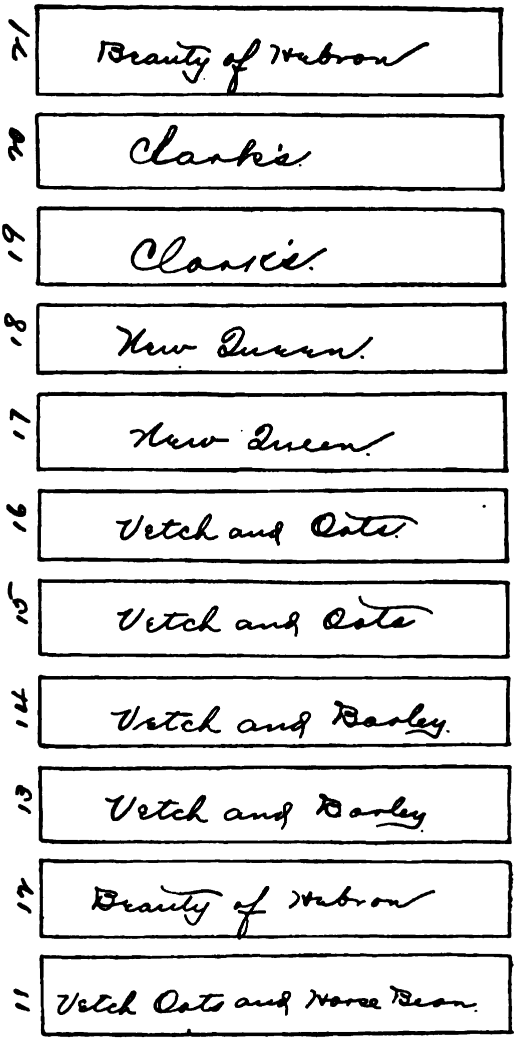
Conclusions.

On the whole, vetch and oats leads vetch and barley, on account of the larger and more foliaceous character of the oats as compared with the barley. Vetch, oats and horse bean leads in nitrogenous matter, and no doubt will exceed in regard to the nutritious character of the crop as soon as the amount of horse bean has been doubled, as indicated above. (Every one of these crops compares well with clover hay.)

The large yield of these crops per acre, their high nutritive value and special adaptation for green fodder, hay or ensilage, merit serious attention for the support of farm and dairy stock.

The early date of maturity presents exceptionally good chances of raising a second crop for fall supply, or for a timely preparation of the soil for winter crops.

Field "B," 1894.



Scale, 4 rods to 1 inch.

3. Field Experiments to ascertain the Influence of Different Mixtures of Commercial Fertilizers on the Yield and General Character of Several Prominent Garden Crops.

Field C.

The area devoted to the above-stated experiment is 198 feet long and 183 feet wide; it is subdivided into six plats of uniform size (89½ by 62 feet, or about one-eighth of an acre each). The plats are separated from each other and from the adjoining cultivated fields by a space of five feet of unmanured and unseeded yet cultivated land. They are arranged in two parallel rows, running from west to east. Nos. 1, 2 and 3 are along the north side of the field, beginning with No. 1 at its west end, while plats Nos. 4, 5 and 6 are located along its south side, beginning with Plat 4 on the west end. The soil is several feet deep, and consists of a light, somewhat gravelly loam, and was in a fair state of productiveness when assigned for the experiment here under consideration.

The entire field occupied by the experiment is nearly on a level. Its earlier history can be learned from previous annual reports.

The observation with raising garden crops, by the aid of different mixtures of commercial manurial substances here under special consideration, began upon plats Nos. 4, 5 and 6 during the spring of 1891, and upon plats Nos. 1, 2 and 3 during that of 1892. The difference of the fertilizers applied consisted in the circumstance that different forms of nitrogen and potash were used for their preparation. All plats received essentially the same quantity of nitrogen, potash and phosphoric acid, and every one of them received its phosphoric acid addition in the same form, namely, dissolved bone-black. Some plats received their nitrogen supply in the form of organic animal matter, dried blood; others in the form of sodium nitrate, Chili saltpetre; others in the form of ammonium sulphate. Some plats received their potash in the form of muriate of potash and others in the form of the highest grade of potassium sulphate (95 per cent.). The subsequent tabular statement shows the quantities of the manurial substances applied to the different plats: —

PLATS.	Annual Supply of Manurial Substances.	Pounds.
Plat 1,	Sulphate of ammonia,	38
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 2,	Nitrate of soda,	47
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 3,	Dried blood,	75
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 4,	Sulphate of ammonia,	38
	Sulphate of potash,	30
	Dissolved bone-black,	40
Plat 5,	Nitrate of soda,	47
	Sulphate of potash,	30
	Dissolved bone-black,	40
Plat 6,	Dried blood,	75
	Sulphate of potash,	30
	Dissolved bone-black,	40

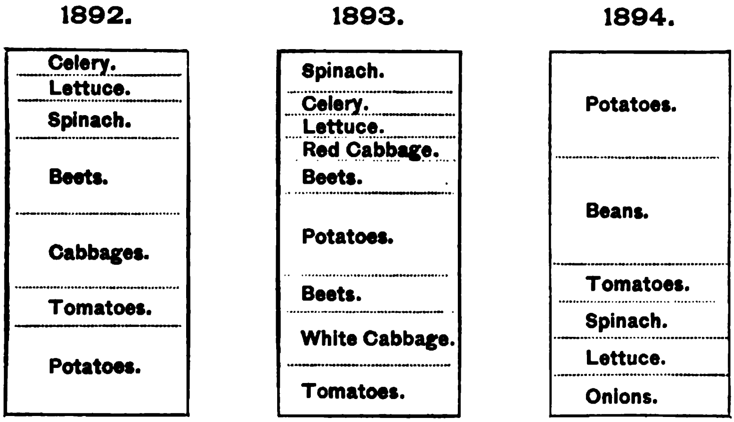
This proportion corresponds per acre to: —

	Pounds.
Phosphoric acid (available),	50.4
Nitrogen,	60.0
Potassium oxide,	120.0

Beets, cabbages, celery, lettuce, spinach, tomatoes and potatoes have thus far been raised upon the field.

The order of arrangement of the different crops within each plat was the same in all of them for the same year. They occupied, however, a different position relative to each other in successive years, to introduce, as far as practicable, a system of rotation of crops.

Order of arrangement of crops in plats: —



A computation of the results of a chemical analysis of twenty prominent garden crops shows the following average relative proportion of the three above-stated essential ingredients of plant food: —

Nitrogen,	2.2
Potassium oxide,	2.0
Phosphoric acid,	1.0

One thousand pounds of green garden vegetables contain, on the above-stated basis of relative proportion of essential constituents of plant food: —

4.1 pounds of nitrogen.
3.9 pounds of potassium oxide.
1.9 pounds of phosphoric acid.

The weights and particular stage of growth of the vegetables when harvested control under otherwise corresponding conditions the actual consumption of each of these articles of plant food. Our information regarding these points is still too fragmentary to enable a more detailed statement here beyond relative proportions. It must suffice for the present to call attention to the fact that a liberal manuring within reasonable limits pays, as a rule, better than a scanty one, especially in the case of those crops which reach in a short period the desired state of maturity.

The various mixtures of fertilizers used by us in the experiments under discussion provide by actual supply for one-half of the available nitrogen actually called for to meet the demand as above pointed out. A liberal cultivation of peas and beans cannot fail to benefit the nitrogen resources of the soil.

1894. — The field was ploughed April 22, and the fertilizer mixtures previously given were applied broadcast the 23d and thoroughly harrowed in. Potatoes, beans, tomatoes, spinach, lettuce and onions were the crops selected for trial in each plat, being arranged as follows, beginning at the west side of each plat: —

Five rows of potatoes (Beauty of Hebron).
Six rows of beans.
Two rows of tomatoes (Essex Hybrid).
Two rows of spinach (New Zealand).
One row of lettuce (Hanson).
Four rows of onions (Yellow Globe Danvers).

Lettuce and tomato plants were raised in the hot-bed and subsequently transferred to the plats. The work of seed sowing and transplanting was done for each particular kind on the same day. April 25 the potatoes were planted, one bushel of seed being used per plat; the spinach and onion seed were put in April 26; the beans on May 7; May 18 the lettuce plants were set out from the hot-bed, and the tomato plants on May 19. The onion plants began to appear May 7; the spinach plants May 9; the potatoes appeared on the 11th, being touched by the frost of the 15th; the beans began to appear May 17, but owing to poor germination on plats 2, 3, 5 and 6 additional seed was put in about the last of May. All crops were kept free from weeds and treated similarly throughout the season. The various crops were harvested whenever fit for the market. A severe drought during the months of July and August affected seriously the yield of crops and the time of harvesting. The subsequent statements give data regarding date of maturity and yield of the different crops.

Yield of Spinach (Variety New Zealand).

Plats.	Pounds.
Plat 1 (two rows), ...	101
Plat 2 (two rows), ...	216
Plat 3 (two rows), ...	165
Plat 4 (two rows), ...	161¾
Plat 5 (two rows).	253
Plat 6 (two rows), ...	113¾

The seed was sown April 26; the crop was harvested July 2.

Yield of Lettuce (Variety Hanson).

Plats.	Perfect Heads.	Pounds.
Plat 1 (one row; eighty-one plants), ...	45	33¼
Plat 2 (one row; one hundred and two plants), .	97	76¾
Plat 3 (one row; one hundred and six plants), .	81	54½
Plat 4 (one row; one hundred and two plants), .	95	74½
Plat 5 (one row; one hundred and six plants), .	104	98½
Plat 6 (one row; ninety-two plants), ...	71	43

The plants were set out May 17; they were harvested June 29.

Yield of Potatoes (Variety Beauty of Hebron).

Plats.	Pounds.		
	Marketable.	Small.	Total.
Plat 1 (five rows), ...	205	115	320
Plat 2 (five rows), ...	240	175	415
Plat 3 (five rows), ...	220	150	370
Plat 4 (five rows), ...	220	170	395
Plat 5 (five rows), ...	195	195	390
Plat 6 (five rows), ...	240	155	395

The potatoes were planted April 25; they were harvested August 7.

Yield of Beans.

Plats.	Pounds.
Plat 1 (six rows), ...	45
Plat 2 (six rows), ...	32
Plat 3 (six rows), ...	41
Plat 4 (six rows), ...	20
Plat 5 (six rows), ...	37
Plat 6 (six rows), ...	49

The beans were planted May 7. The germination on plats 2, 3, 5 and 6 was very imperfect, and May 27 extra seed was put in on these plats. June 25 first of plants came into bloom; they were threshed August 17.

Yield of Onions (Variety Yellow Globe Danvers).

PLATS.	Pounds.
Plat 1 (four rows),	156
Plat 2 (four rows),	249
Plat 3 (four rows),	251
Plat 4 (four rows),	256
Plat 5 (four rows),	266
Plat 6 (four rows),	204

The seed was sown April 26; the crop was harvested September 24.

Yield of Tomatoes (Variety Essex Hybrid).

DATE OF HARVESTING.	POUNDS.					
	1.	2.	3.	4.	5.	6.
August 10 (matured),	–	3	10	9	7	8
August 14 (matured),	8	25	12	13	12	12
August 17 (matured),	29	77	40	52	60	31
August 20 (matured),	38	71	82	81	79	69
August 23 (matured),	22	43½	47	41½	48	38
August 27 (matured),	56	77	61	93	74	69
August 31 (matured),	54	70	56	92	76	66
September 4 (matured),	31	45	40	46	50	56
September 10 (matured),	60	68	54	85	112	66
Total weight of matured tomatoes,	298	489	402	512	518	415
September 11 (green),	54	70	56	92	76	56
Total weight of green and matured,	352	559	458	604½	594	571

There were two rows of tomatoes in each plat, with 22 plants in each row. They were set out May 19 and began to bloom June 5.

Potatoes (Variety Beauty of Hebron).

Plats.	Pounds.			
	1891.	1892.	1893.	1894.
Plat 1 (five rows), . . .	–	585	400	320
Plat 2 (five rows), . . .	–	665	520	415
Plat 3 (five rows), . . .	–	545	390	370
Plat 4 (five rows), . . .	735	640	525	395
Plat 5 (five rows), . . .	780	740	520	390
Plat 6 (five rows), . . .	–	435	580	395

Tomatoes (Variety Essex Hybrid).

Plats.	Pounds.			
	1891.	1892.	1893.	1894.
Plat 1 (two rows), . . .	–	464	363	352
Plat 2 (two rows), . . .	–	572	874½	559
Plat 3 (two rows), . . .	–	466	807	458
Plat 4 (two rows), . . .	641	515	818	604
Plat 5 (two rows), . . .	647	593	978½	594
Plat 6 (two rows), . . .	–	332	515	571

Lettuce (Variety Hanson).

SEVENTY PLANTS.	1892.	1893.	1894.
Plat 1 (one row), ...	41½	40½	29
Plat 2 (one row), ...	36	42	52
Plat 3 (one row), ...	43	46	36
Plat 4 (one row), ...	76	62	50
Plat 5 (one row), ...	60	70	68
Plat 6 (one row), ...	36	55	33

Spinach (Variety New Zealand).

PLATS.	1892.	1893.	1894.
Plat 1 (two rows), ...	192	167½	101
Plat 2 (two rows), ...	233	182	216
Plat 3 (two rows), ...	202	180½	165
Plat 4 (two rows), ...	230	-	161¾
Plat 5 (two rows), ...	232	210	253
Plat 6 (two rows), ...	134	198½	113¾

From our observations as above reported, extending over three years, we may draw the following conclusions: —

Potash in the form of sulphate has given the most satisfactory results, as compared with muriate, in the case of potatoes, tomatoes, lettuce and spinach, and with onions during the present season.

Nitrogen in the form of nitrate of soda has given us, without regard to the potash source, the most satisfactory returns in case of spinach, lettuce, potatoes and tomatoes, and with onions during the present season.

Lettuce (sampled July 6, 1893).

	Plat 1 (Per Cent.).	Plat 4 (Per Cent.).
Moisture at 100° C.,	96.93	96.97
Dry matter,	3.07	3.03
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	17.84	15.66
" fibre,	13.35	14.11
" fat,	3.36	3.44
" protein,	23.83	26.85
Nitrogen-free extract matter,	41.62	39.94
	100.00	100.00

Fertilizing Constituents.

Moisture at 100° C.,	96.930	96.970
Calcium oxide,	.026	.026
Magnesium oxide,	.005	.003
Sodium oxide,	.015	.018
Potassium oxide,	.241	.233
Phosphoric acid,	.017	.036
Nitrogen,	.117	.130
Insoluble matter,	.124	.104

Spinach (sampled July 12, 1893).

	Plat 1 (Per Cent.).	Plat 4 (Per Cent.).
Moisture at 100° C.,	92.80	91.63
Dry matter,	7.20	8.37
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	29.47	29.06
" fibre,	12.49	11.77
" fat,	2.42	2.12
" protein,	25.45	28.53
Nitrogen-free extract matter,	30.17	28.52
	100.00	100.00

Fertilizing Constituents.

Moisture at 100° C.,	92.800	91.630
Calcium oxide,	.054	.065
Magnesium oxide,	.049	.052
Sodium oxide,	.199	.230
Potassium oxide,	.838	1.076
Phosphoric acid,	.046	.055
Nitrogen,	.293	.382
Insoluble matter,	.273	.272

Beets.

	Plat 1 (Per Cent.).	Plat 4 (Per Cent.).
Moisture at 100° C.,	79.54	82.91
Dry matter,	20.46	17.09
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	5.46	5.72
" fibre,	5.68	5.88
" fat,	.33	.36
" protein,	14.56	13.59
Nitrogen-free extract matter,	73.97	74.45
	100.00	100.00

Fertilizing Constituents.

Moisture at 100° C.,	79.540	82.910
Calcium oxide,	.143	.077
Magnesium oxide,	.031	.025
Sodium oxide,	.098	.125
Potassium oxide,	.524	.450
Phosphoric acid,	.136	.113
Nitrogen,	.476	.368
Insoluble matter,	.109	.106

Cabbage.

	Plat 1 (Per Cent.).	Plat 4 (Per Cent.).
Moisture at 100° C.,	92.95	93.74
Dry matter	7.05	6.26
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	9.76	6.80
" fibre,	15.69	14.57
" fat,	1.95	2.46
" protein,	3.16	3.85
Nitrogen-free extract matter,	69.44	72.32
	100.00	100.00

Fertilizing Constituents.

Moisture at 100° C.,	92.950	93.740
Calcium oxide,	.026	.024
Magnesium oxide,	.010	.010
Sodium oxide,	.040	.029
Potassium oxide,	.363	.299
Phosphoric acid,	.017	.036
Nitrogen,	.223	.241
Insoluble matter,	.217	.165

Tomatoes.

	Plat 1 (Per Cent.).	Plat 4 (Per Cent.).
Moisture at 100° C.,	93.51	94.44
Dry matter,	6.49	5.56
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	7.99	7.18
" fibre,	9.71	9.40
" fat,	4.96	4.95
" protein,	16.57	20.85
Nitrogen-free extract matter,	60.77	57.62
	100.00	100.00

Fertilizing Constituents.

Moisture at 100° C.,	93.510	94.440
Calcium oxide,	.030	.024
Magnesium oxide,	.019	.014
Sodium oxide,	–*	–*
Potassium oxide,	.353	.356
Phosphoric acid,	.045	.039
Nitrogen,	.170	.185
Insoluble matter,	.011	.021

* Not determined.

Potatoes.

	Plat 1 (Per Cent.).	Plat 4 (Per Cent.).
Moisture at 100° C.,	80.71	81.17
Dry matter,	19.29	18.83
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	4.71	4.64
" fibre,	2.26	2.35
" fat,	.54	.42
" protein,	10.98	10.06
Nitrogen-free extract matter,	81.51	82.53
	100.00	100.00

Fertilizing Constituents.

Moisture at 100° C.,	80.710	81.170
Calcium oxide,	.018	.020
Magnesium oxide,	.044	.041
Sodium oxide,	.029	.024
Potassium oxide,	.607	.553
Phosphoric acid,	.065	.048
Nitrogen,	.338	.303
Insoluble matter,	.026	.048

Field C, Eastern Portion.

The part of Field C east of the experiment plats is 183 by 131 feet, and contains .55 acre, being divided into two equal portions by the strip of uncultivated land passing through the centre of the field. The fertilizer applied consisted of 300 pounds of fine-ground bone and 100 pounds of muriate of potash. A strip 20 feet wide was set off at the western side of the portion for special trials with vegetables, etc. The northern portion remaining was used for the production of carrots and the southern portion for globe mangolds. In both cases the seed was put in May 4 and the young plants appeared above ground the 14th. The field was kept free from weeds during the growing season, and the mangolds were harvested on October 9, yielding 3,840 pounds of roots, or 15,368 pounds per acre. The carrots were harvested October 11, giving 5,563 pounds, or 22,363 pounds per acre. The space west of the mangolds was used for trials with oats. Three varieties, sent on by J. A. Everett, Indianapolis, Ind., were tested. They were: No. 1, Colgarry Gray; No. 2, Rust Proof; and No. 3, White Superior Scotch. Two rows of each (89 feet long) were planted. The oats were sown in drills May 4 and germinated May 10.

Height of Oats.

[Inches.]

	June 5	June 12.	June 26.	July 3.
No. 1, Colgarry Gray, ...	8	15	23	30
No. 2, Rust Proof, ...	7	12	18	20
No. 3, White Superior Scotch, ...	9	15	26	30

The oats were somewhat affected by rust during the season, No. 2 suffering more than the others. June 29 the oats began to head out. Nos. 1 and 3 were cut July 16; No. 2, several days later.

Yield of Oats.

[Pounds.]

	Total Weight.	Grain.	Straw.	Per Cent. of Grain.
No. 1, Colgarry Gray,	38	15	23	39.50
No. 2, Rust Proof,	43	4½	38½	10.40
No. 3, White Superior Scotch,	41	7½	33½	18.30

The space west of the carrots was given to the raising of peas, Wisconsin tree bean, bush lima bean and potatoes. The peas were sent on for trial by James J. H. Gregory & Son, Marblehead, Mass., and were numbered 1, 2 and 3, there being one row of each. They were planted May 4, coming up about the 11th. June 11 No. 1 began to bloom, and June 14 Nos. 2 and 3, the different rows having then the following heights: —

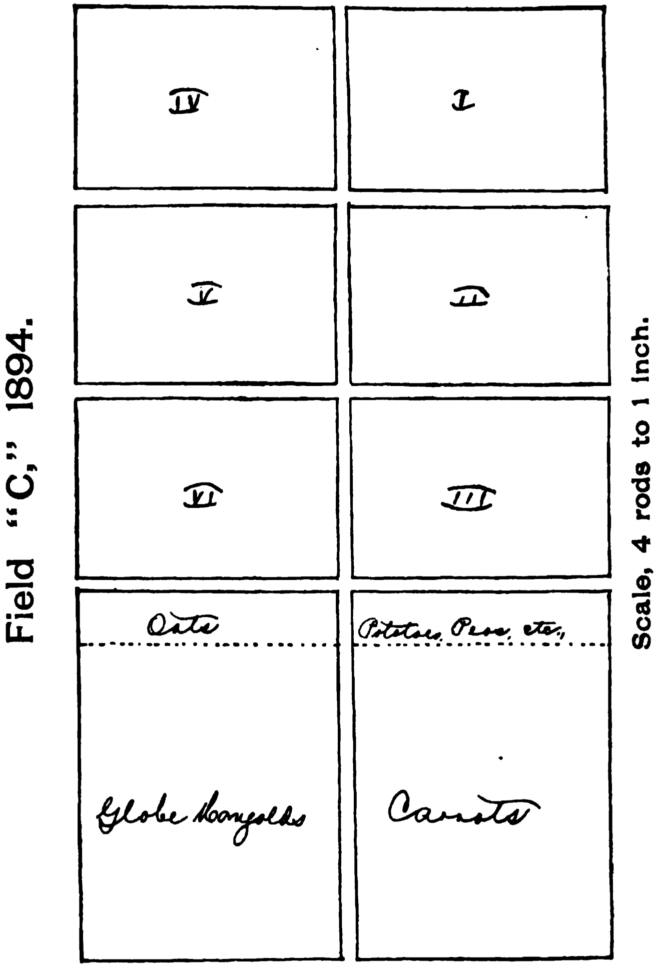
	Inches.
No. 1,	12
No. 2,	6
No. 3,	11

June 25 there were pods ready for picking on No. 1; June 29, on No. 2, with a few on No. 3. No. 1 proved to be the best yielder.

West of the peas was one row each of bush lima beans and Wisconsin tree beans. The lima beans were sent on by the United States Department of Agriculture and the Wisconsin tree beans by J. A. Everett. The Wisconsin tree beans came into bloom June 25 and the bush lima beans on July 9, but the latter failed to reach maturity.

The remaining row was planted to a variety of potatoes, Nos. 1–6 of which were sent on by J. A. Everett, Indianapolis, Ind., and No. 7 by Richard Nott, Burlington, Vt. They were planted May 4, and May 17 No. 1 began to appear; Nos. 2, 3, 5 and 6 on the 20th; No. 7 on the 23d and No. 4 on the 24th. July 5 Nos. 1, 2, 3 and 6 were noted as coming into bloom, the others being a little later. August 22 the tubers were dug, and yielded as follows: —

No.	NAME.	No. of Hills.	No. of Tubers.	Total Weight. lbs. oz.	Market-able Tubers	Weight. lbs. oz.	Small Tubers.	Weight lbs. oz.
1	**Early Everett,**	5	68	10 14	34	7 12	34	3
2	**Rural New Yorker,**	6	53	9 12	39	8 10	14	1 4
3	**Colossal,**	7	74	13 12	43	10 12	31	3
4	**Heavy Weight,**	6	77	7 14	15	3	62	4 14
5	**Everett's Six Weeks,**	5	64	5 11	16	2 13	48	2 14
6	**Green Mountain,**	6	68	12 4	40	9 15	28	2 5
7	**Nott's Seedling No. 7,**	2	19	3 9	13	3 3	6	6



4. EXPERIMENTS WITH FORAGE CROPS (TWENTY-SEVEN).

Field D.

This field has been used for the past three years for the raising of a variety of reputed annual and perennial fodder crops, in the majority of cases new to our section of the country, to study their adaptation to our climate and soil. Some of them have since been raised on a larger scale successfully and profitably for the support of our dairy stock, as southern cow-pea, serradella, early-maturing soja bean, late-maturing soja bean, summer vetch and oats, summer vetch and barley, and vetch, oats and horse bean.

The field is 328 feet long and 70 feet wide, covering an area of 22,960 square feet, or .527 acre. The field was ploughed April 30, and May 1 a fertilizer mixture was applied at the rate of 600 pounds of fine-ground bone and 200 pounds of muriate of potash per acre. The fertilizer was applied broadcast and harrowed in. The different crops were planted in rows two and one-half feet apart, and were kept free from weeds throughout the season. They were arranged in the field during the past season in the following order, beginning at the west end: —

Prickly comfrey (*Symphytum officinalis*).
Alfalfa (*Medicago sativa*).
Kidney vetch (*Anthyllis vulneraria*).
Forest pea or flat pea (*Lathyrus sylvestris*).
Crimson clover (*Trifolium incarnatum*).
Alsike clover (*Trifolium hybridum*).
Medium red clover (*Trifolium medium*).
Sainfoin (*Onobrychis sativa*).
Japanese clover (*Lespedeza striata*).
Winter rape (*Brassica napus*).
Dwarf Essex rape (*Brassica napus*).
Serradella (*Ornithopus sativus*).
Vetch (*Vicia sativa*).
Bokhara clover (*Melilotus alba*).
Yellow lupine (*Lupinus lutens*).
Blue lupine (*Lupinus perennis*).
White lupine (*Lupinus alba*).
Southern cow-pea (*Dolichos sinensis*).

Horse bean (*Vicia faba*).
Early-maturing soja bean (*Soja hispida*).
Late-maturing soja bean (*Soja hispida*).
Silver-hull buckwheat (*Fagopyrum esculentum*).
Japanese buckwheat (*Fagopyrum esculentum*).
Common buckwheat (*Fagopyrum esculentum*).
Hog millet.
Golden wonder millet.
Spanish peanut.

Prickly comfrey (*Symphytum officinalis*), one row. The roots remained in the ground and wintered well during the winter of 1893–94, but were moved to their present position before the field was ploughed during the spring. The crop made a good growth, coming into bloom June 1. June 14 a part of it was cut for feeding (containing 86.67 per cent. moisture); the remainder was cut June 21. A second growth was made, which was cut during the fall. Following is given the analysis of the crop: —

	Per Cent.
Moisture at 100° C.,	86.67
Dry matter,	13.33
	100.00
Analysis of Dry Matter.	
Crude ash,	21.12
" fibre,	11.03
" fat,	2.06
" protein,	17.49
Nitrogen-free extract matter,	48.00
	100.00
Fertilizing Constituents.	
Moisture at 100° C.,	86.79
Dry matter contains: —	
Nitrogen,	2.80
Potassium oxide,	5.76
Phosphoric acid,	.87

This plant has been recommended as a forage crop for dairy stock which can be grown upon lands where leguminous crops fail to give satisfactory results.

Alfalfa (*Medicago sativa*), five rows. The seed was purchased of J. M. Thorburn & Co., New York, at twenty cents per pound. The seed was sown May 10, appearing above ground May 17. The plants were twelve inches high July 3, fourteen inches high July 10. They suffered greatly from the effects of the dry weather. Following is an average analysis of the crop as hay: —

	Per Cent.
Moisture at 100° C.,	9.60
Dry matter,	91.40
	100.00

Analysis of Dry Matter.

Crude ash,	8.11
" fibre,	29.72
" fat,	1.65
" protein,	14.22
Nitrogen-free extract matter,	46.20
	100.00

Dry matter contains: —	
Nitrogen,	2.21
Potassium oxide,	1.55
Phosphoric acid,	.56

We have experimented with alfalfa at different times during the existence of the station, as will be noted from previous annual reports, with but little encouragement, as the crop suffered seriously from winter-killing.

Kidney vetch (*Anthyllis vulneraria*), five rows. The seed was sown May 10, the plants appearing May 25. Being a perennial, the growth of the present season was but slight. Below is given an analysis of the second growth, cut when in bloom: —

	Per Cent.
Moisture at 100° C.,	80.85
Dry matter,	19.15
	100.00

Analysis of Dry Matter.

Crude ash,	13.28
" fibre,	14.94
" fat,	3.51
" protein,	18.43
Nitrogen-free extract matter,	48.94
	100.00

Dry matter contains: —	
Nitrogen,	2.94
Potassium oxide,	1.75
Phosphoric acid,	.44

This plant prospers particularly upon a sandy soil, where other leguminous plants fail to give satisfactory returns. Its cultivation has of late received considerable attention in leading agricultural districts of Europe, for the above reason.

Flat pea or forest pea (*Lathyrus sylvestris*), six rows. Four rows remained in the ground from last season, but, having winter-killed somewhat, they were combined into two. On May 10 four rows were sown with seed obtained of Delano Bros., Lee Park, Neb. The young plants began to appear above ground June 6. The two rows of older plants made a good growth, coming into bloom June 18. It was cut July 12 for feeding, having then formed a number of pods. The sample for analysis was taken at this time: —

	Per Cent.
Moisture at 100° C.,	78.80
Dry matter,	21.20
	100.00

Analysis of Dry Matter.

Crude ash,	9.35
" fibre,	28.27
" fat,	3.29
" protein,	27.26
Nitrogen-free extract matter,	31.83
	100.00
Dry matter contains: —	
Nitrogen,	4.36
Potassium oxide,	2.57
Phosphoric acid,	.90

Our results thus far obtained are not encouraging as far as adaptation to our clime and soil is concerned. The plant grows slowly during its earlier period, and has suffered repeatedly from winter-killing. Its high nutritive value may be judged from the above analysis. Whether it is acceptable to dairy stock as green fodder is somewhat in question. Judging from the observations of others, its best use is as silage.

Crimson clover (*Trifolium incarnatum*), six rows. The seed was sown May 10, appearing above ground the 15th. The growth during the early part of the season was promising, but the dry weather made practically a failure of it as far as yield was concerned. The seed was purchased of J. M. Thorburn & Co., New York, at twelve and one-half cents per pound. As the crop had suffered from the drought considerably when reaching its maturity, the analysis was left for another season.

Alsike clover (*Trifolium hybridum*), six rows. The seed was sown May 10, the young plants beginning to appear above ground May 17. This crop was also seriously affected by the drought. The seed was obtained of J. M. Thorburn & Co., New York, at 25 cents per pound. An average analysis of the dry material is given below: —

	Per Cent.
Moisture at 100° C.,	9.93
Dry matter,	90.07
	100.00

Analysis of Dry Matter.

Crude ash,	11.90
" fibre,	26.17
" fat,	2.58
" protein,	16.63
Nitrogen-free extract matter,	42.72
	100.00

Dry matter contains: —

Nitrogen,	2.48
Potassium oxide,	2.47
Phosphoric acid,	.74

This variety of clover has served us well in our meadows, it being seeded every two years at the rate of three to four pounds per acre, applied in the spring.

Medium red clover (*Trifolium medium*), five rows. The seed was sown May 10, first appearing above ground May 17. The crop did not make sufficient growth, on account of the dry weather, so that it was not cut. The seed was purchased of J. M. Thorburn & Co., New York, at fifteen cents per pound. Below is given an analysis of the dry fodder: —

	Per Cent.
Moisture at 100° C.,	11.41
Dry matter,	88.59
	100.00

Analysis of Dry Matter.

	Per Cent.
Crude ash,	9.84
" fibre,	27.51
" fat,	2.13
" protein,	15.75
Nitrogen-free extract matter,	44.77
	100.00
Dry matter contains: —	
Nitrogen,	2.37
Potassium oxide,	2.48
Phosphoric acid,	.48

As this is the standard variety of clover for use on grass lands, no further discussion with regard to its merits is needed.

Sainfoin (*Onobrychis sativa*), four rows. The sainfoin remained in the ground from last year, the five rows being reduced to four. It started into growth well, and May 19 had commenced to bloom. It was sampled for analysis on May 28 and June 7, being cut for feeding June 11, when thirty inches high. It made a very good second growth, coming into bloom July 17.

	May 28 (Per Cent.).	June 7 (Per Cent.).
Moisture at 100° C.,	79.49	76.27
Dry matter,	20.51	23.73
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	8.06	9.56
" fibre,	22.62	22.49
" fat,	2.83	2.78
" protein,	15.95	18.11
Nitrogen-free extract matter,	50.55	47.06
	100.00	100.00

Fertilizing Constituents.

	Per Cent.
Moisture at 100° C.,	12.17
Dry matter contains: —	
Nitrogen,	2.99
Potassium oxide,	2.29
Phosphoric acid,	.86

This crop requires a calcareous soil and dry subsoil to do its best.

Japanese clover (*Lespedeza striata*), five rows. Seed sown May 10, first appearing above ground June 1. Being a perennial, the plant did not make sufficient growth to permit of an analysis. The seed was sent on by the United States Department of Agriculture.

Winter rape (*Brassica napus*), five rows. The seed was sown May 10, the young plants appearing above ground May 15. The seed was obtained of D. Landreth & Sons, Philadelphia, Pa. July 6 a portion of the rape was cut and fed out, being about fourteen inches high. Analysis at this period: —

	Per Cent.
Moisture at 100° C.,	83.34
Dry matter,	16.66
	100.00

Analysis of Dry Matter.

Crude ash,	22.44
" fibre,	12.26
" fat,	3.06
" protein,	15.16
Nitrogen-free extract matter,	47.08
	100.00

Dwarf Essex rape (*Brassica napus*), five rows. The seed was sown May 10, appearing above ground May 17. It made a good growth. July 6 one row was cut for feeding, being twenty-three inches high at the time. Analysis of a sample taken at this time showed it to have the following composition: —

	Per Cent.
Moisture at 100° C.,	94.57
Dry matter,	5.43
	100.00

Analysis of Dry Matter.

	Per Cent.
Crude ash,	16.11
" fibre,	18.96
" fat,	3.80
" protein,	12.86
Nitrogen-free extract matter,	42.27
	100.00

Both varieties of rape are known as valuable fodder plants, as well as suitable crops for green manuring. Neither of these varieties come to blooming during the present season. They are expected to furnish valuable green fodder during the coming season.

Serradella (*Ornithopus sativus*), five rows. The seed was sown May 10, the plants appearing above ground May 21. The crop made a good growth, coming into bloom July 5. July 10 the plants were eleven inches high. The seed was purchased of Henry Nungesser, New York, at ten cents per pound. Following is given an average of the analyses of serradella made at the station: —

	Per Cent.
Moisture at 100° C.,	82.41
Dry matter,	17.59
	100.00

Analysis of Dry Matter.

Crude ash,	10.99
" fibre,	30.08
" fat,	2.41
" protein,	15.01
Nitrogen-free extract matter,	41.51
	100.00

Fertilizing Constituents.

Dry matter contains: —

Nitrogen,	2.40
Potassium oxide,	.70
Phosphoric acid,	.84

We have used serradella for several years as a fodder crop for green fodder as well as silage. It has been raised in drills three feet six inches apart, yielding nine and one-half tons of green fodder per acre.

Spring vetch (*Vicia sativa*). The vetch was sown April 26, the seed coming up May 4. Seed was used at the rate of forty-five pounds per acre. The vetch came into bloom June 23, when twenty-eight inches high. The seed was purchased of J. M. Thorburn & Co., New York, at seven cents per pound. Analysis of the dried crop shows it to have the following composition: —

	Per Cent.
Moisture at 100° C.,	9.90
Dry matter,	91.10
	100.00

Analysis of Dry Matter.

Crude ash,	8.24
" fibre,	30.27
" fat,	2.50
" protein,	15.09
Nitrogen-free extract matter,	43.80
	100.00

Fertilizing Constituents.

Moisture at 100° C.,	8.21
Dry matter contains: —	
Nitrogen,	2.40
Phosphoric acid,	.86
Potassium oxide,	3.00

Bokhara clover (*Melilotus alba*), five rows. This crop remained in the ground from last year. It started into growth early, and on May 28 about twelve feet from the north end of each of the rows was cut for feeding, being about thirty inches high. June 7 another portion was cut for feeding, being thirty-six inches in height. June 18 the plants were coming into bloom at forty-five inches in height. June 22 the remaining portion was cut and fed out, being five feet in height. The seed was bought of Henry Nungesser, New York, at twenty cents per pound. Analysis of the crop collected at different dates gave the following results: —

	Per Cent.		
	May 28.	June 7.	June 22
Moisture at 100° C.,	87.43	80.99	75.86
Dry matter,	12.51	19.01	24.14
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	11.67	10.21	7.71
" fibre,	24.43	29.98	33.99
" fat,	3.51	2.76	2.88
" protein,	23.37	18.62	17.18
Nitrogen-free extract matter,	37.02	38.43	38.24
	100.00	100.00	100.00

This crop furnishes a liberal amount of fodder the first and second years. It should be cut before the plant reaches blooming, to preserve its succulent character. When advanced beyond that stage of growth it becomes coarse and is rejected by cattle.

Yellow lupine (*Lupinus lutens*), six rows. The seed was sown May 9, coming up May 23, but not germinating very well. July 12 the plants were coming into bloom, being about one foot in height. The seed was obtained of D. Landreth & Son, Philadelphia. Analysis of the plant shows it to have the following composition: —

	Per Cent.
Moisture at 100° C.,	86.05
Dry matter,	13.95
	100.00
Analysis of Dry Matter.	
Crude ash,	11.14
" fibre,	27.10
" fat,	1.87
" protein,	17.84
Nitrogen-free extract matter,	42.05
	100.00

Fertilizing Constituents.

Dry matter contains: —	Per Cent.
Nitrogen,	2.66
Potassium oxide,	2.96
Phosphoric acid,	.61

Blue lupine (*Lupinus cœruleus*), three rows. The seed was sown May 9, the plants appearing above ground May 19. The plants came into bloom July 12, when about two feet in height. The seed was obtained of J. M. Thorburn, New York, at fifteen cents per pound.

White lupine (*Lupinus albus*), six rows. The seed was sown May 9, the young plants appearing above ground May 19. The plants came into bloom June 28. July 10 it was noted as being twenty-five inches high. The seed was purchased of D. Landreth & Son, Philadelphia, at six cents per pound. The composition of the plant is stated below: —

	Per Cent.
Moisture at 100° C.,	85.35
Dry matter,	14.65
	100.00

Analysis of Dry Matter.

Crude ash,	5.03
" fibre,	31.18
" fat,	2.41
" protein,	18.71
Nitrogen-free extract matter,	42.67
	100.00

Fertilizing Constituents.

Dry matter contains: —	
Nitrogen,	2.99
Potassium oxide,	1.73
Phosphoric acid,	.35

The lupines have served us well as green manuring crops. They may be seeded the beginning of May and are ready to be ploughed under the beginning of June, or may be seeded the latter part of August and are ready for ploughing under the latter part of September.

Southern cow-pea (*Dolichos sinensis*), five rows. The seed was sown May 9, the young plants appearing above ground May 19. The crop made a good growth, and was sampled for analysis on August 28 and October 2. The seed was purchased of D. Landreth & Son, Philadelphia. The analysis of the crop showed the following composition: —

	August 28 (Per Cent.).	October 2 (Per Cent.).
Moisture at 100° C.,	81.81	80.60
Dry matter,	18.19	19.40
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	11.20	9.96
" fibre,	17.87	20.52
" fat,	4.63	3.81
" protein,	17.19	16.41
Nitrogen-free extract matter,	49.11	49.30
	100.00	100.00

Two prominent varieties (Clay and Whippoorwill) have been raised successfully for a number of years, and have served us well as fodder crops either green or in the form of silage. None of these varieties mature seed in our section of the country.

Horse bean (*Vicia faba*), five rows. The seed was sown May 9, and first appeared above ground May 21. The plants first began to blossom June 28. July 10 the plants had reached a height of twenty-one inches. Below is given an analysis of the crop with pods forming: —

	Per Cent.
Moisture at 100° C.,	84.83
Dry matter,	15.17
	100.00

Analysis of Dry Matter.

	Per Cent.
Crude ash,	5.75
" fibre,	28.17
" fat,	2.31
" protein,	16.68
Nitrogen-free extract matter,	47.09
	100.00

Horse bean stands our climate extremely well, the medium-sized variety seeming to be the best for us. We have during the past year raised it as a mixed crop with vetch and oats, and are pleased with the results.

Early-maturing soja bean (*Soja hispida*), raised on Field A. The seed was planted May 12, in drills two and one-half feet apart, at the rate of sixty pounds per acre. The young plants began to appear May 21. July 24 the plants on the different plats began to bloom. The yield of the crop was affected considerably by the dry weather. The crop was cut August 28, being put into a silo with corn for the production of a mixed silage. Below is given the analysis of the above crop: —

	Per Cent.
Moisture at 100° C.,	65.98
Dry matter,	34.02
	100.00

Analysis of Dry Matter.

Crude ash,	9.69
" fibre,	17.28
" fat,	2.96
" protein,	20.13
Nitrogen-free extract matter,	49.94
	100.00

Later-maturing soja bean (*Soja hispida*), five rows. The seed was sown May 9, the young plants first appearing above ground May 21. The crop made a very vigorous growth, and was sampled for analysis at two different periods. The seed was obtained of J. M. Thorburn & Co., New York. The results of the examination of the samples collected are as follows: —

	August 28 (Per Cent.).	October 26 (Per Cent.).
Moisture at 100° C.,	70.91	68.11
Dry matter,	29.09	31.89
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	10.34	8.43
" fibre,	21.09	21.20
" fat,	3.11	2.34
" protein,	27.49	23.16
Nitrogen-free extract matter,	37.97	44.84
	100.00	100.00

Fertilizing Constituents.

Dry matter contains: —		
Nitrogen,	4.39	3.70
Potassium oxide,	–*	–*
Phosphoric acid,	–*	–*

* Not determined.

The above samples were raised on Field A, in 1892, in drills two and one-half feet apart, using seventy pounds of seed per acre, and securing on an average nine to ten tons per acre, which served as mixed ensilage with corn. The addition of leguminous plants, as clover, soja beans, serradella, etc., to corn for silage tends to counteract the acid reaction of the corn silage and furnishes a most acceptable article for feeding.

Silver-hull buckwheat (*Fagopyrum esculentum*), eight rows. The seed was sown May 9, the young plants appearing above ground May 16. It came into bloom June 18, and was cut for feeding out July 14, when about three feet in height. The seed was purchased of J. M. Thorburn & Co., New York, at ten cents per pound. An analysis of the dried crop, cut when in bloom, gave the following results: —

	Per Cent.
Moisture at 100° C.,	8.91
Dry matter,	91.09
	100.00

Analysis of Dry Matter.

Crude ash,	10.17
" fibre,	27.07
" fat,	2.55
" protein,	12.22
Nitrogen-free extract matter,	47.99
	100.00

Fertilizing Ingredients.

Dry matter contains: —	
Nitrogen,	1.95
Potassium oxide,	2.61
Phosphoric acid,	.94

Japanese buckwheat (*Fagopyrum esculentum*), seven rows. The seed was sown May 9, the young plants appearing above ground May 16. The first blossoms appeared June 18, and the crop was cut for green fodder July 14. The seed was purchased of J. M. Thorburn & Co., New York, at ten cents per pound. Below is given an analysis of the air-dried material, collected when in bloom: —

	Per Cent.
Moisture at 100° C.,	5.71
Dry matter,	94.29
	100.00

Analysis of Dry Matter.

Crude ash,	12.36
" fibre,	36.02
" fat,	2.22
" protein,	10.80
Nitrogen-free extract matter,	38.60
	100.00

Fertilizing Constituents.

Dry matter contains: —	
Nitrogen,	1.72
Potassium oxide,	3.51
Phosphoric acid,	.90

Both the silver-hull and Japanese varieties of buckwheat are on the whole larger plants and more foliaceous, and consequently yield a larger amount per acre. The Japanese variety seems to be the better of the two.

Common buckwheat (*Fagopyrum esculentum*), seven rows. The seed was sown May 9, the young plants appearing above ground May 18. June 18 the plants came into bloom. July 13 the crop was cut and fed out. The seed was obtained of D. Landreth & Son, Philadelphia, at five cents per pound. Below is given an analysis of the dried material: —

	Per Cent.
Moisture at 100° C.,	8.50
Dry matter,	91.50
	100.00

Analysis of Dry Matter.

Crude ash,	14.63
" fibre,	19.35
" fat,	3.04
" protein,	17.90
Nitrogen-free extract matter,	45.08
	100.00

Fertilizing Constituents.

Dry matter contains: —	
Nitrogen,	2.866
Potassium oxide,	3.504
Phosphoric acid,	.547

Common buckwheat yields somewhat less than the previously mentioned varieties, yet its nutritive character, under a corresponding system of cultivation and manuring, exceeds that of either one.

Hog millet, five rows. The seed was sown May 9, and began to come up May 17. This variety did not make as satisfactory growth as the next. It commenced to head out July 10, when twenty-four inches high. The seed was sent on by the Northrup, Braslon, Goodwin Company, Minneapolis, Minn.

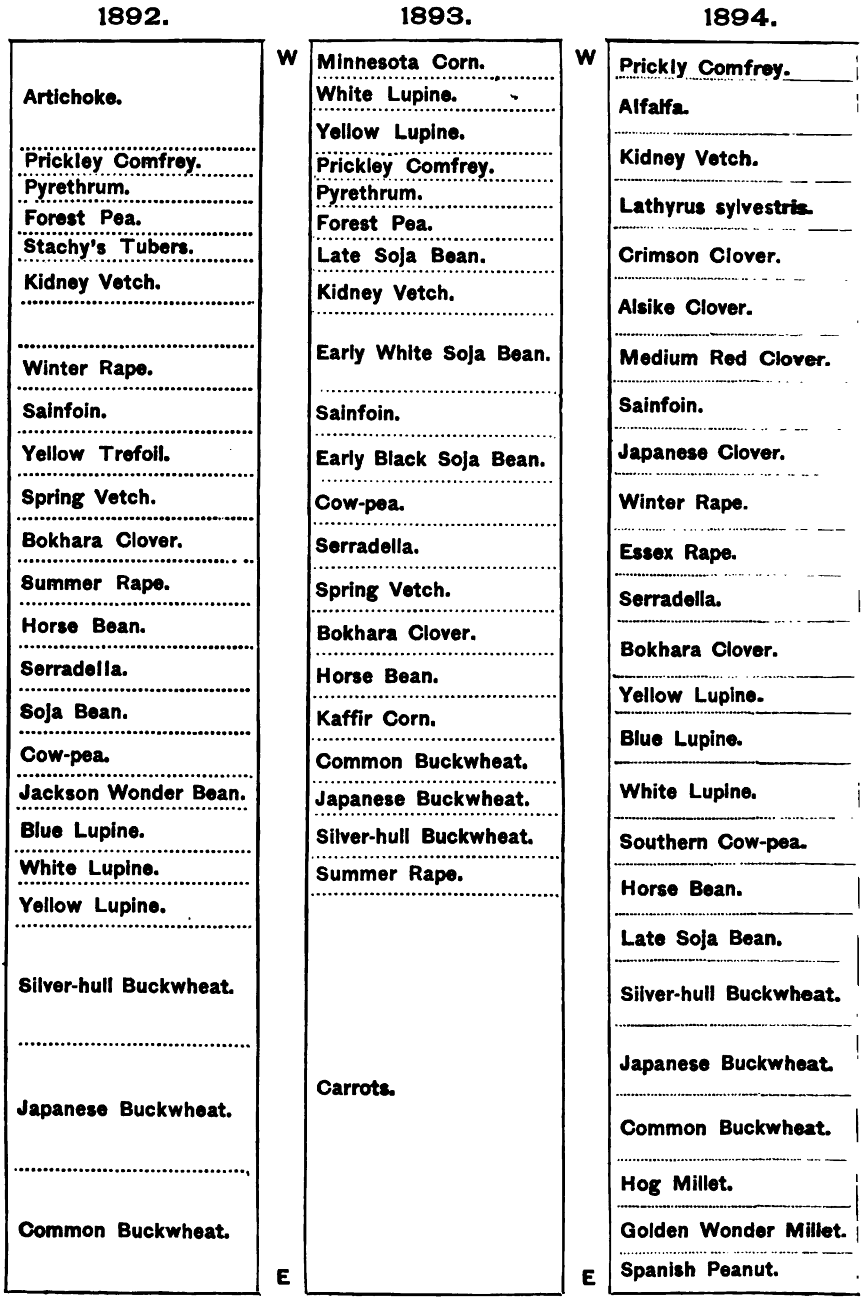
Golden wonder millet, five rows. The seed was sown May 9, and began to come up May 17. The crop made a very good growth, and July 9 began to head out, when twenty-six inches high. The seed was sent on by the Northrup, Braslon, Goodwin Company, Minneapolis, Minn.

The millets both yield a large crop, but, as the seed was somewhat mixed, no weights have been taken.

Spanish peanut (*Arachis hypogœa*), two rows. The peanuts were planted May 10, coming into bloom July 16. As the amount of seed received and used was small, no data are given with regard to yield, etc. The peanuts were sent on by the United States Department of Agriculture.

We have seeded down during the early part of September, 1894, rye, winter vetch and rye and dwarf Essex rape, to secure, if possible, a supply of valuable green fodder during the middle or latter part of May. The winter vetch used for this purpose was especially imported, to test its adaptation to our climate. Previous experiments in this direction failed, as we suppose, on account of getting summer vetch in place of winter vetch.

Field "D."—Arrangement of Crops raised.



1892.

- Artichoke.
- Prickley Comfrey.
- Pyrethrum.
- Forest Pea.
- Stachy's Tubers.
- Kidney Vetch.
- Winter Rape.
- Sainfoin.
- Yellow Trefoil.
- Spring Vetch.
- Bokhara Clover.
- Summer Rape.
- Horse Bean.
- Serradella.
- Soja Bean.
- Cow-pea.
- Jackson Wonder Bean.
- Blue Lupine.
- White Lupine.
- Yellow Lupine.
- Silver-hull Buckwheat.
- Japanese Buckwheat.
- Common Buckwheat.

W

1893.

- Minnesota Corn.
- White Lupine.
- Yellow Lupine.
- Prickley Comfrey.
- Pyrethrum.
- Forest Pea.
- Late Soja Bean.
- Kidney Vetch.
- Early White Soja Bean.
- Sainfoin.
- Early Black Soja Bean.
- Cow-pea.
- Serradella.
- Spring Vetch.
- Bokhara Clover.
- Horse Bean.
- Kaffir Corn.
- Common Buckwheat.
- Japanese Buckwheat.
- Silver-hull Buckwheat.
- Summer Rape.
- Carrots.

E

W

1894.

- Prickly Comfrey.
- Alfalfa.
- Kidney Vetch.
- Lathyrus sylvestris.
- Crimson Clover.
- Alsike Clover.
- Medium Red Clover.
- Sainfoin.
- Japanese Clover.
- Winter Rape.
- Essex Rape.
- Serradella.
- Bokhara Clover.
- Yellow Lupine.
- Blue Lupine.
- White Lupine.
- Southern Cow-pea.
- Horse Bean.
- Late Soja Bean.
- Silver-hull Buckwheat.
- Japanese Buckwheat.
- Common Buckwheat.
- Hog Millet.
- Golden Wonder Millet.
- Spanish Peanut.

E

Scale of length, 50 feet to 1 inch.

Compilation of Analyses of Fodder Articles raised (1894).

NAME OF CROP.	Dry Matter.	100 PARTS OF DRY MATTER CONTAIN — Ash.	Fibre.	Fat.	Protein.	Nitrogen-free Extract Matter.	DRY MATTER CONTAINS — Nitrogen.	Phosphoric Acid.	Potassium Oxide.
I. Leguminous Plants.									
Flat pea (*Lathyrus sylvestris*),	21.20	9.35	28.27	3.29	27.26	31.83	4.36	.90	2.57
Late-maturing soja bean,	29.09	10.34	21.09	3.11	27.49	37.97	4.39	-	-
Late-maturing soja bean,	31.89	8.43	21.20	2.34	23.18	44.84	3.70	-	-
Early-maturing soja bean,	34.02	9.69	17.28	2.96	20.13	49.94	3.22	-	-
Bokhara clover,	12.57	11.67	24.43	3.51	23.37	37.02	3.73	-	-
Bokhara clover,	19.01	10.21	29.98	2.76	18.62	38.43	2.97	-	-
Bokhara clover (in bloom),	24.14	7.71	33.99	2.88	17.18	38.24	2.90	-	-
Kidney vetch,	19.15	13.28	14.94	3.51	18.43	48.94	2.94	.44	1.75
White lupine,	14.65	5.03	31.18	2.41	18.71	42.67	2.99	.35	1.73
Yellow lupine,	13.95	11.14	27.10	1.87	17.84	42.05	2.66	.61	2.96
Southern cow-pea,	18.19	11.20	17.87	4.63	17.19	49.11	2.75	.58	1.04
Alsike clover,	90.07	11.90	26.17	2.58	16.63	42.72	2.48	.74	2.47
Medium red clover,	88.59	9.84	27.51	2.13	15.75	44.77	2.37	.48	2.48
Sainfoin,	23.73	9.56	22.49	2.78	18.11	47.06	2.99	.86	2.29
Spring vetch,	91.10	8.24	30.27	2.50	15.09	43.80	2.40	.86	3.00
Serradella,	17.59	10.99	30.08	2.41	15.01	41.51	2.40	.84	.70
Alfalfa,	91.40	8.11	29.72	1.65	14.22	46.20	2.21	.56	1.55
II. Miscellaneous Crops.									
Common buckwheat,	91.50	14.63	19.35	3.04	17.90	45.08	2.87	.55	3.50
Silver-hull buckwheat,	91.09	10.17	27.07	2.55	12.22	47.99	1.95	.94	2.61
Japanese buckwheat,	94.29	12.36	36.02	2.22	10.80	38.60	1.72	.90	3.51
Prickly comfrey,	13.33	21.12	11.03	2.06	17.49	48.00	2.80	.87	5.76
Dwarf Essex rape,	5.43	16.11	18.96	3.80	12.86	42.27	2.05	-	-
Winter rape,	16.66	22.44	12.26	3.06	15.16	47.08	2.42	-	-

NAME OF CROP.	Dry Matter.	DRY MATTER CONTAINS — Crude Ash.	Crude Fibre.	Crude Fat.	Crude Protein.	Nitrogen-free Extract Matter.
III. Mixed Crops (Dried).						
Vetch and oats, Field G, 1894,	91.05	4.48	27.78	2.62	22.56	42.56
Vetch and oats, Field B, Plat 15, 1894,	90.64	9.59	29.83	3.13	18.88	38.57
Vetch and oats, Field B, Plat 16, 1894,	90.65	8.69	31.28	2.63	15.16	42.24
Vetch and barley, Field B, Plat 13, 1894,	91.51	4.64	32.25	2.12	14.44	46.55
Vetch and barley, Field B, Plat 14, 1894,	90.76	7.80	32.58	2.56	13.36	43.70
Vetch, oats and horse bean, Field B, Plat 11, 1894,	89.81	10.36	30.07	2.70	18.93	77.94

The raising of fodders richer in nitrogenous constituents than our meadow growth (upland meadow hay) and pasture growth enables us to reduce the expenses for commercial concentrated feed stuffs to produce the desired well-balanced nutritive fodder rations for our farm live stock.

How can Forage Crops assist in improving the Productiveness of our Farm Lands?

The consideration of this important question claims the serious attention of every thinking and progressive farmer, for nobody questions the correctness of the view that a successful termination of his work depends in a controlling degree on a correct appreciation of the extent and character of his resources of plant food and on a liberal and intelligent use of the latter.

An insufficient supply of suitable manurial matter, required for the successful and liberal production of the crops to be raised, is at present universally recognized as being the most fatal circumstance in any system of farming for profit. Adopting this conclusion as the correct verdict of past and present experience in agricultural industries, it becomes most desirable, in the interest of satisfactory pecuniary returns, that every available manurial resource of the farm should be turned to account to its full extent. *To secure this end we are advised to begin the work with a timely thorough mechanical preparation of the soil under cultivation; to select the crops to be raised, as far as practicable, with reference to their tendency of economizing existing natural resources of plant food; to increase the latter to the full extent of suitable home-made manure on hand, and to supplement the latter liberally by buying commercial concentrated fodder articles and commercial fertilizer, as far as circumstances advise.*

To again discuss * briefly one of the means of developing and economizing manurial sources of the farm is the object of this chapter.

On Production and Selection of Fodder Crops.

A careful inquiry into the history of agriculture, down to the middle of the present century, has shown that the original productiveness of farm lands in all civilized countries, even in the most favored localities, has suffered in the course of time a gradual decline. This general decline in the fertility of the soil under cultivation has been ascribed, with much propriety in the majority of instances, mainly to two causes, namely: a gradual but serious reduction in the area occupied by forage crops, natural pastures and meadows; and a marked decline in the annual yield of fodder upon large tracts of land but ill suited for a permanent cultivation of grasses, — the main reliance of fodder production at the time. A serious falling off in the annual yield of pastures and meadows was followed usually by a reduction in farm live stock, which in turn caused a falling off in the principal home resource of manurial matter. This chapter in the history of farm management has repeated itself in most countries. The unsatisfactory results of that system of farming find still an abundant illustration in the present exhausted condition of a comparatively large area of farm lands in New England.

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* See annual reports for 1889 (page 189) and 1890 (page 135); also Bulletin No. 36,

Scientific investigations carried on during the past fifty years for the particular benefit of agriculture have not only been instrumental in recognizing the principal causes of an almost universal periodical decline of the original fertility of farm lands, but have also materially assisted by field experiments and otherwise in introducing efficient remedies to arrest the noted decline in the annual yield of our most prominent farm crops. As a scanty supply of manurial matter, due to a serious falling off of one of the principal fodder crops (pastures and meadow growth), was found to be one of the chief causes of less remunerative crops, and thus indirectly has proved to be the main cause of an increase in the cost of the products of the animal industry of the farm, — milk and meat, — it is but natural that the remedies devised should include, as one of the foremost recommendations, a more liberal production of nutritious fodder crops. The soundness of this advice is to-day fully demonstrated in the most successful agricultural regions of the world. An intensive system of cultivation has replaced in those localities the extensive one of preceding periods; although the area under cultivation for the production of general farm crops has been reduced, the total value of the products of the farm has increased materially in consequence of a more liberal cultivation of reputed fodder crops. The change has been gradual and the results are highly satisfactory.

Viewing our own present condition, we notice that well-paying grass land, good natural meadow, with rich and extensive pastures, are rather an exception than the rule. The benefits derived from indifferently yielding natural pastures are more apparent than real; the low cost of the production of the fodder is frequently, in a large degree, set off by a mere chance distribution of the manure produced. A continued cultivation of one and the same crop upon the same land, without a liberal, rational system of manuring, has caused in many instances a one-sided exhaustion of the land under cultivation. This circumstance has frequently been brought about in a marked degree by a close rotation of mixed grasses (meadow growth) and of our next main reliance for fodder,—the corn (maize). Both crops require potash and phosphoric acid in similar proportion (four parts potassium oxide to one part phosphoric acid), and both require an exceptional amount of the former. There is good reason to assume that the low state of productiveness of many of our farms, so often complained of, is largely due to the fact that crops have been raised in succession for years, which, like those mentioned, have consumed one or the other essential article of plant food in an exceptionally large proportion, and thereby have gradually unfitted the soil for their remunerative production, while a liberal supply of other important articles of plant food is left inactive behind. As the amount of available plant food contained in the soil represents largely the working capital of the farmer, it cannot be otherwise but that the practice of allowing a part of it to lay idle must reduce the interest on the investment.

Our personal observation upon the lands assigned for the use of the station has furnished abundant illustration of the above-described condition of farm lands. In one instance it was noticed that a piece of old worn-out grass land, after being turned under and properly prepared, as far as the mechanical condition of the soil was concerned, produced, without any previous application of manure, an exceptionally large crop of horse beans and lupine,—two reputed fodder crops. A similar observation was made during the past season, when lands which for years had been used for the production of English hay and corn were used for the cultivation of southern cow-pea, serradella and a mixed crop of oats and vetch, to serve as green fodder for milch cows.

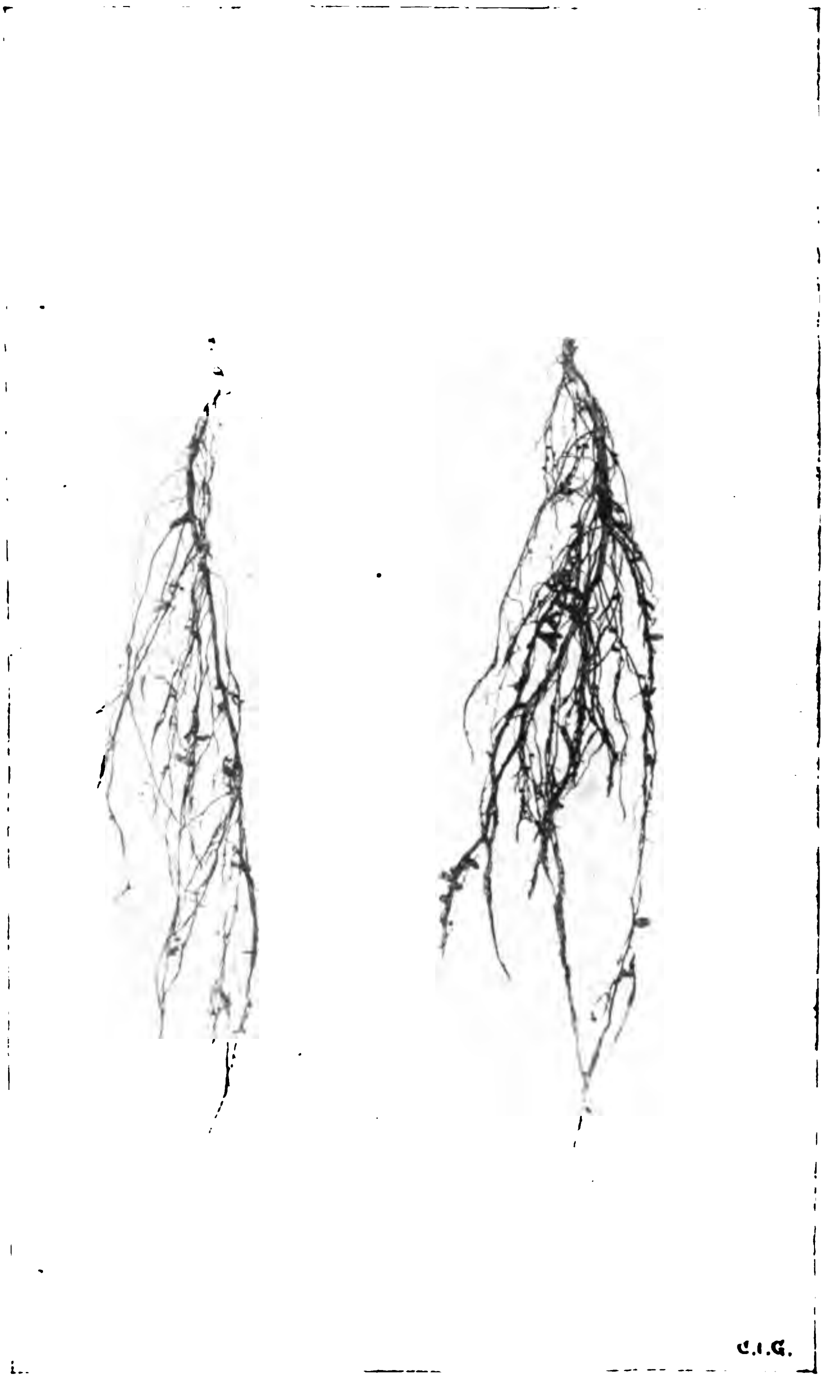
The field engaged for the production of these crops was not manured, because it was to be prepared for a special field experiment during the present season. An area of this land, which, under favorable circumstances, would not produce more than six tons of green grass at the time of blooming, yielded nine to ten tons of green vetch and oats, ten tons of green southern cow-pea and from twelve to thirteen tons of green serradella. The exceptional exhaustion of our lands in potash has been shown by detailed description of experiments with fodder corn in previous annual reports. (Field A, annual reports IV., V. and VI., 1886–88.)

The results obtained during past years tend to confirm the opinion held by successful agriculturists, that dry grass lands which are in an exceptional degree inclined to a spontaneous overgrowing by an inferior class of fodder plants and weeds, if at all fit for a more thorough system of cultivation, ought to be turned by the plough and subsequently planted with some hoed crop, to kill off the foul growth and to improve the physical and chemical condition of the soil. These lands prove in many instances ultimately a far better investment when used for the raising of other farm crops than grasses. The less the variety of crops raised in succession upon the same lands, the more one-sided is usually the exhaustion of the soil, and the sooner, as a rule, will be noticed a decrease in the annual yield. The introduction of a greater variety of fodder plants enables us to meet better the differences in local conditions of climate and of soil, as well as the special wants of different branches of farm industry. In choosing plants for that purpose it seems advisable to select crops which would advantageously supplement our leading fodder crop (aside from the products of pastures and meadows), — the fodder corn and corn stover.

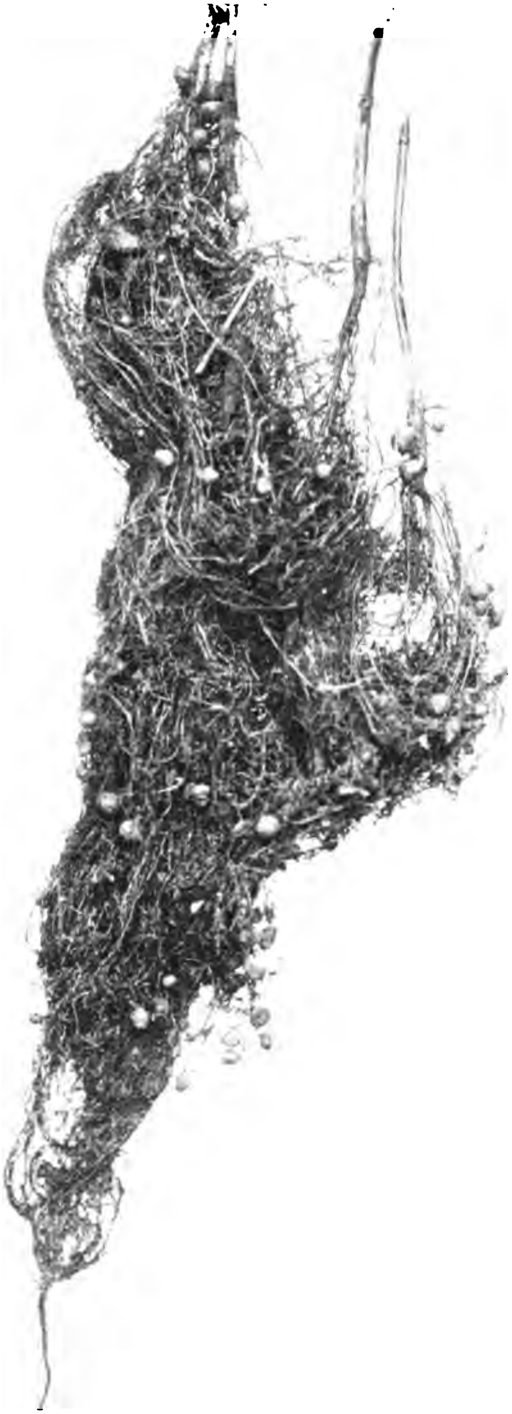
Taking this view of the question, the great and valuable family of leguminous plants, as clovers, vetches, lucerne, serradella, peas, beans, lupines, etc., is, in a particular degree, well qualified for that purpose on account of its fitness to secure largely its nitrogen from the elementary nitrogen of the air by the aid of bacterial action. The photographs of the roots of several prominent leguminous forage-plants, which accompany this chapter, show the swellings (tubercules) due to the bacterial action, — summer vetch, blue lupine, horse bean, serradella.

The following table may serve as an illustration of the relative economical value of various prominent fodder and forage crops.

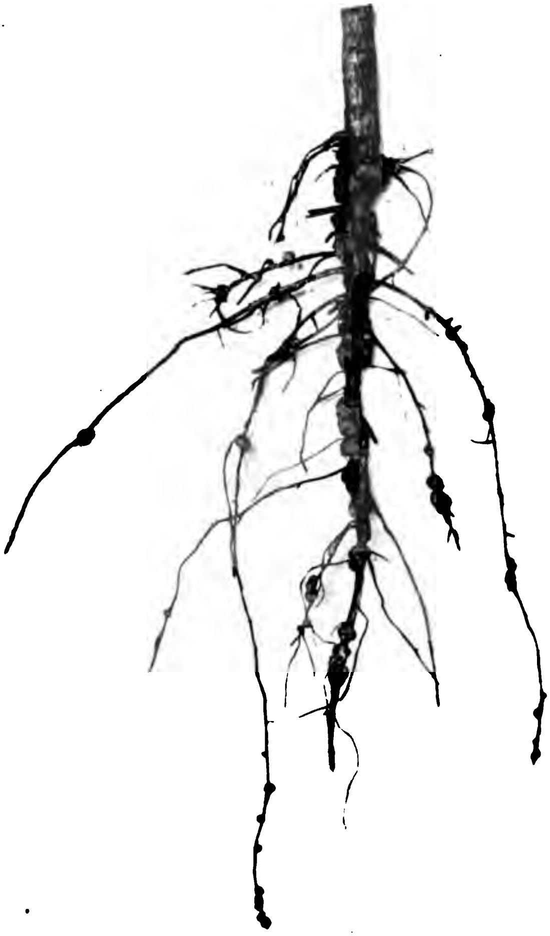
The manurial value of the various crops mentioned depends for obvious reasons on the temporary current prices of their fertilizing constituents in the general market of commercial fertilizers.



No. 1. Summer Vetch (*Vicia sativa*).

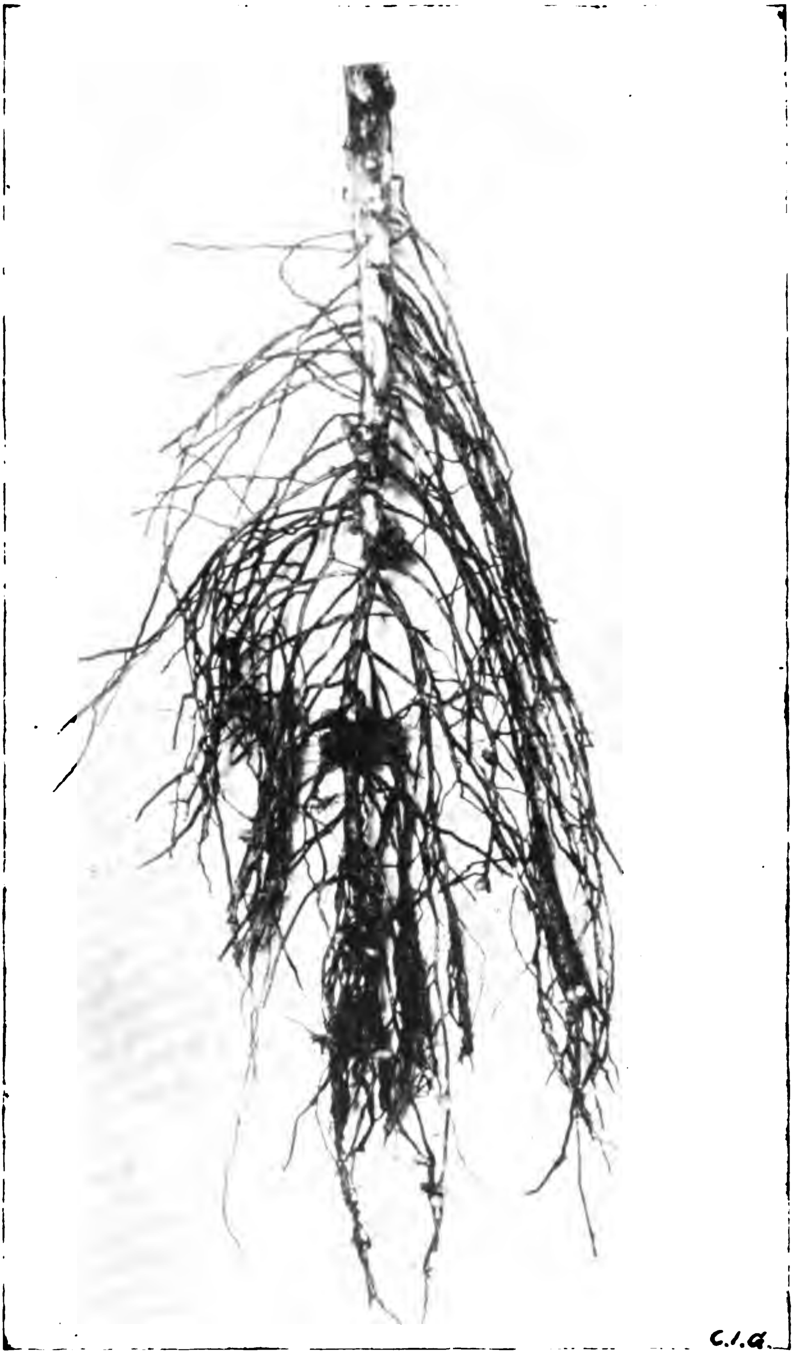


No. 2. Soja Bean (*Soja hispida*).



C.I.G.

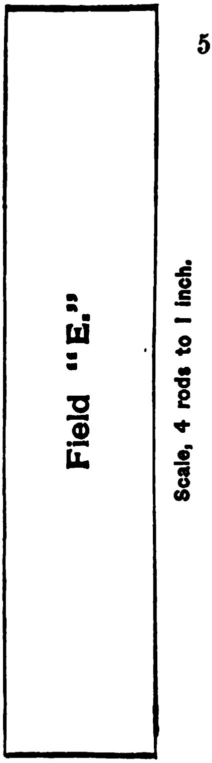
No. 8. Blue Lupine (*Lupinus cæruleus*).



No. 4. Horse Bean (*Vicia Faba*).

Composition of Fodder Crops raised upon the Station Grounds.

NAME OF CROP. (SUITABLE FOR FEEDING.)	Nutritive Ratio.	FODDER CONSTITUENTS (IN POUNDS) IN 1,000 POUNDS OF DRY MATTER.					FERTILIZING CONSTITUENTS (IN POUNDS) IN 1,000 POUNDS OF DRY MATTER.			Manurial Value per Ton of Dry Matter.
		Crude Ash.	Crude Cellulose.	Crude Fat.	Crude Protein (Nitrogenous Matter).	Non-nitrogenous Extract Matter.	Nitrogen.	Phosphoric Acid.	Potassium Oxide.	
Medium clover (*Trifolium pratense*),	1:2.5 to 1:5.5	89.0	299.7	26.2	146.3	438.8	23.40	4.88	24.65	$10 64
Alsike clover (*Trifolium hybridum*),		116.7	261.8	26.6	162.2	432.7	25.88	7.81	24.72	11 86
Cow-pea (*Dolichos*),		69.2	235.9	24.8	145.9	524.2	23.40	5.79	14.44	9 86
Serradella (*Ornithopus sativus*),		116.9	324.9	23.7	149.6	384.9	23.94	8.04	24.12	11 15
Vetch (*Vicia sativa*),		82.4	303.7	25.0	150.9	438.0	24.14	5.47	12.75	9 95
Soja bean (*Soja hispida*),		75.1	212.6	59.9	154.0	497.5	24.78	4.66	16.53	10 89
Lucerne (*Medicago sativa*),		81.1	297.2	16.5	142.2	463.0	22.75	5.61	15.59	9 73
Herds grass (*Phleum pratense*),	1:5.5 to 1:9.5	53.3	328.7	20.1	85.2	512.7	13.95	4.97	16.54	6 75
Corn stover,		50.3	320.2	16.5	79.2	533.8	12.67	4.22	18.39	6 88
Fodder corn,		48.8	314.0	15.3	72.1	549.8	11.54	7.38	10.99	5 75
Oats (entire plant),		60.8	343.2	26.9	108.9	460.2	17.42	7.81	22.90	8 81
Barley (entire plant),		49.5	291.2	27.6	102.6	529.1	16.42	6.44	19.53	8 02
Millet,		54.9	335.4	17.4	75.9	516.4	12.14	5.08	10.89	5 66
Hungarian grass (*Setaria italica*),		71.5	246.6	10.1	93.8	578.0	15.01	6.24	13.50	7 00
Japanese buckwheat,		123.6	360.2	22.2	108.0	386.0	17.28	9.04	35.21	9 95
Sugar beets,	1:9.5 to 1:13	46.4	60.0	6.5	108.4	778.7	17.34	5.41	18.57	8 12
Ruta-bagas,		97.5	118.3	15.3	110.1	658.8	17.62	10.76	41.06	10 77
Mangel-wurzels,		90.6	79.4	3.8	108.7	717.5	16.59	7.32	30.13	9 08
Carrots,		81.4	95.3	25.0	88.4	709.9	14.14	10.02	54.11	10 61



5. Trial of an Early Variety of Minnesota Dent Corn (Huron).

Field E.

The field is 260 feet long and 48 feet wide, containing .286 acres. The field was ploughed April 24; it was fertilized May 7, at the rate of 600 pounds of fine-ground bone and 300 pounds of muriate of potash per acre, applied broadcast and harrowed in. May 8 the corn (variety Huron) was planted, six quarts of seed being used for the plat. The corn appeared above ground May 19. The field was cultivated and hoed June 7 and 26. September 1 part of the corn was cut and stocked, while the remainder was fed out. Owing to the dry season, this trial with the corn was not a fair one, as the development of the crop was greatly retarded.

6. FIELD EXPERIMENTS WITH DIFFERENT COMMERCIAL PHOSPHATES TO STUDY THE ECONOMY OF USING THE CHEAPER NATURAL PHOSPHATES OR THE MORE COSTLY ACIDULATED PHOSPHATES.

Field F.

The field selected for this purpose is 300 feet long and 137 feet wide, running on a level from east to west. Previous to 1887 it was used as a meadow, which was well worn out at that time, yielding but a scanty crop of English hay. During the autumn of 1887 the sod was turned under and left in that state over winter. It was decided to prepare the field for special experiments with phosphoric acid by a systematic exhaustion of its inherent resources of plant food. For this reason no manurial matter of any description was applied during the years 1887, 1888 and 1889.

The soil, a fair sandy loam, was carefully prepared every year by ploughing during the fall and in the spring, to improve its mechanical condition to the full extent of existing circumstances. During the same period a crop was raised every year. These crops were selected, as far as practicable, with a view to exhaust the supply of phosphoric acid in particular. Corn, Hungarian grass and leguminous crops (cow-pea, vetch and serradella) followed each other in the order stated.

1890. — The field was subdivided into five plats, running from east to west, each twenty-one feet wide, with a space of eight feet between adjoining plats.

The manurial material applied to each of these five plats contained, in every instance, the same form and the same quantity of potassium oxide and of nitrogen, while the phosphoric acid was furnished in each case in the form of a different commercial phosphoric-acid-containing article, namely, phosphatic slag, Mona guano, Florida phosphate, South Carolina phosphate (floats) and dissolved bone-black. The market cost of each of these articles controlled the quantity applied, for each plat received the same money value in its particular kind of phosphate.

Cost per Ton.

Phosphatic slag,	$15 00
Mona guano (West Indies),	15 00
Florida rock phosphate,	15 00
South Carolina phosphate (floats),	15 00
Dissolved bone-black,	25 00

Analyses of Phosphates used.

[I., phosphatic slag; II., Mona guano; III., Florida phosphate; IV., South Carolina phosphate; V., dissolved bone-black.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture,	0.47	12.52	2.53	0.39	15.96
Ash,	–	75.99	89.52	–	61.46
Calcium oxide,	46.47	37.49	17.89	46.76	–
Magnesium oxide,	5.05	–	–	–	–
Ferric and aluminic oxides,	14.35	–	14.25	5.78	–
Total phosphoric acid,	19.04	21.88	21.72	27.57	15.82
Soluble phosphoric acid,	–	–	–	–	12.65
Reverted phosphoric acid,	–	7.55	–	4.27	2.52
Insoluble phosphoric acid,	–	14.33	–	23.30	0.65
Insoluble matter,	4.39	2.45	30.50	9.04	6.26

The following fertilizer mixtures have been applied annually to all the plats, with the exception of Plat 3, which received in 1890 ground apatite and in 1891 no phosphate whatever: —

Plats.	Annual Supply of Manurial Substances.	Pounds.
Plat 1 (south, 6,494 square feet),	Ground phosphatic slag,	127
	Nitrate of soda,	43
	Potash-magnesia sulphate,	58
Plat 2 (6,565 square feet),	Ground Mona guano,	128
	Nitrate of soda,	43½
	Potash-magnesia sulphate,	59
Plat 3 (6,636 square feet),	Ground Florida phosphate,	129
	Nitrate of soda,	44
	Potash-magnesia sulphate,	59
Plat 4 (6,707 square feet),	South Carolina phosphate,	131
	Nitrate of soda,	44½
	Potash-magnesia sulphate,	60
Plat 5 (6,778 square feet),	Dissolved bone-black,	78
	Nitrate of soda,	45
	Potash-magnesia sulphate,	61

The phosphatic slag, Mona guano, South Carolina phosphate and Florida phosphate were applied at the rate of 850 pounds per acre; dissolved bone-black at the rate of 500 pounds per acre. Nitrate of soda was applied at the rate of 250 pounds per acre and potash-magnesia sulphate at the rate of 390 pounds per acre.

Potatoes were raised upon the plats in 1890; in 1891 winter wheat was employed (for details see ninth annual report); in 1892 serradella was the crop experimented with (see tenth annual report); and in 1893 a variety of Dent corn, Pride of the North (see eleventh annual report).

1894. — During the preceding season it was decided to ascertain the after-effect of the phosphoric acid applied during previous years by excluding it from the fertilizer applied. In addition, to secure the full effect of the phosphoric acid stored up, the potassium oxide and nitrogen were increased one-half, as compared with preceding seasons. A grain crop (barley) calling for a liberal amount of phosphoric acid was chosen for the trial. The field was ploughed April 17, the fertilizer being applied broadcast April 26, and harrowed in. Below is given a statement of fertilizer applied: —

Plat 1 (6,494 square feet), ...	64½ pounds of nitrate of soda. 87 pounds of potash-magnesia sulphate.
Plat 2 (6,565 square feet), ...	65¼ pounds of nitrate of soda. 88 pounds of potash-magnesia sulphate.
Plat 3 (6,636 square feet), ...	66 pounds of nitrate of soda. 89 pounds of potash-magnesia sulphate.
Plat 4 (6,707 square feet), ...	66¾ pounds of nitrate of soda. 90 pounds of potash-magnesia sulphate.
Plat 5 (6,778 square feet), ...	67½ pounds of nitrate of soda. 90⅞ pounds of potash-magnesia sulphate.

May 2 the barley was sown in drills two feet apart, at the rate of two bushels per acre. May 8 the barley was coming up on the plat. The field was kept free from weeds by cultivation.

Height of Plants.

[Inches.]

	Plat 1.	Plat 2.	Plat 3.	Plat 4.	Plat 5.
June 12, ...	14	13	10	14	14
June 18, ...	18	15	12	16	16
June 26, ...	28	26	21	24	27

June 26 the plants on plats 1, 2, 4 and 5 were beginning to show heads; No. 3 was somewhat behind the others. July 30 the barley was cut. The yield of barley from the different plats is given below: —

Yield of Crop (1894).

PLATS.	Grain and Straw (Pounds).	Grain (Pounds).	Straw and Chaff (Pounds).	Percentage of Grain.	Percentage of Straw.
Plat 1, ...	490	169	221	34.49	65.51
Plat 2, ...	405	148	251	34.07	65.93
Plat 3, ...	290	78	212	26.89	73.11
Plat 4, ...	460	144	216	31.30	68.70
Plat 5, ...	390	118	272	30.26	69.74

Summary of Yield of Crop (1890–94).

PLATS.	1890. Potatoes.	1891. Wheat.	1892. Serradella.	1893. Corn.	1894. Barley.
Plat 1, ...	1,600	380	4,070	1,660	490
Plat 2, ...	1,415	340	3,410	1,381	405
Plat 3, ...	1,500	215	2,750	1,347	290
Plat 4, ...	1,830	380	3,110	1,469	460
Plat 5, ...	2,120	405	2,920	1,322	390

Phosphoric Acid applied to and removed from Field.

[Pounds.]

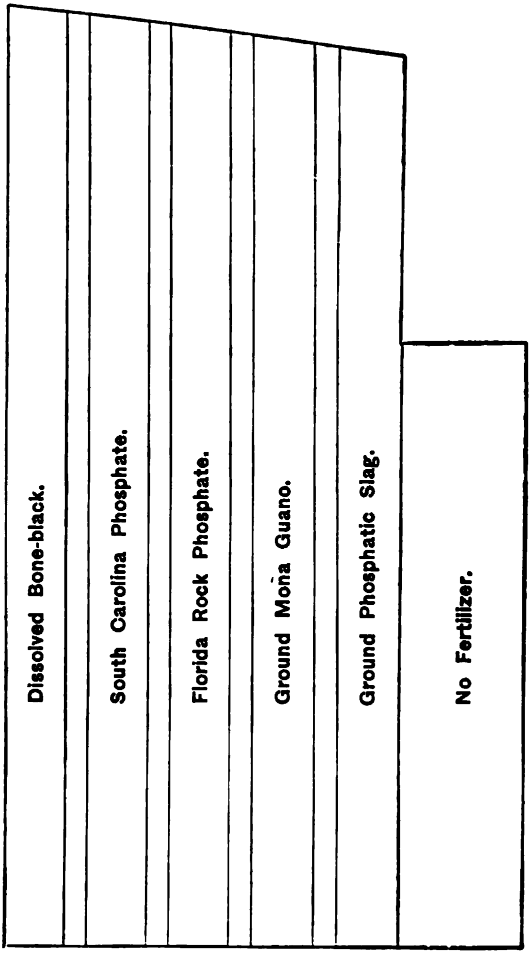
PLATS.	1890.		1891.		1892.		1893.		1894.		Total Amount Added.	Total Amount Removed.	Total Amount Remaining.
	Added.	Removed.	Added.	Removed.	Added.	Removed.	Added.	Removed.	Added.	Removed.			
Plat 1, .	24.18	2.56	24.18	1.23	24.18	8.95	24.18	7.20	-*	1.92	96.72	21.86	75.86
Plat 2, .	28.01	2.36	28.01	1.19	28.01	7.50	28.01	6.33	-*	1.64	72.04	19.02	53.02
Plat 3, .	109.68	2.40	-*	.69	28.01	6.05	28.01	5.95	-*	.76	165.70	15.85	149.85
Plat 4, .	36.12	2.93	36.12	1.31	36.12	6.84	36.12	6.68	-*	1.72	144.48	19.84	124.64
Plat 5, .	12.34	3.39	12.34	1.22	12.34	6.42	12.34	6.05	-*	1.49	49.36	18.57	30.79

* None.

Conclusions.

From the previous statement of comparative yield we find that the plat receiving dissolved bone-black leads in yield during the first two years, while for the third, fourth and fifth years the plats receiving insoluble phosphates are ahead, phosphatic slag being first, South Carolina floats second and Mona guano third.

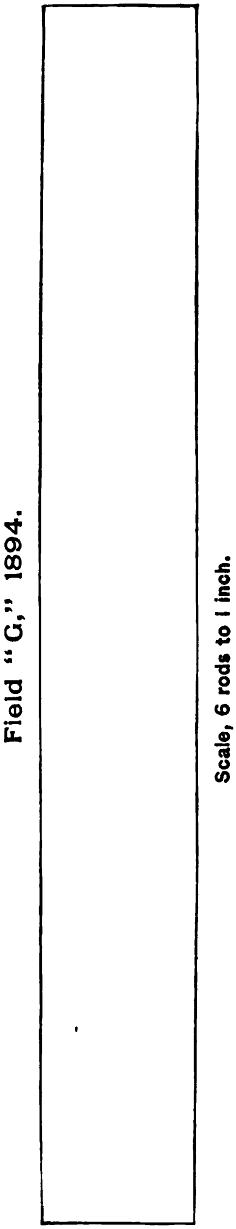
Field "F," 1894.



Barley.

Scale, 4 rods to 1 inch.

7. EXPERIMENTS WITH FORAGE CROPS (VETCH AND OATS FOR FIRST CROP, HUNGARIAN GRASS FOR SECOND).


Field "G," 1894.

Field G.

The field is 700 feet long and 75 feet wide, and contains 52,500 square feet, or 1⅕ acres. The field was ploughed Oct. 25, 1893. April 17 the artichokes were removed from the southern end of the field (see preceding annual report). It was fertilized with barnyard manure, applied at the rate of ten tons per acre. The field was again ploughed April 18. Vetch and oats was the crop selected for trial, being sown at the rate of forty-five pounds of vetch and four bushels of oats per acre. The field was seeded in two portions. The seed was sown on the northern portion April 20, coming up April 28. The southern portion of the field was seeded May 11, the plants appearing above ground May 19. The crop made a very satisfactory growth, and on June 23 the feeding of the green material from the northern portion began (the vetch being in bloom and the oats heading out), continuing until July 2, when that remaining was cut for hay. July 6 the cutting from the southern portion began, continuing until the 18th, when that remaining was cut for hay. Following is given a statement of the yield from the field :—

	Pounds.
Green material fed (19.12 per cent. dry matter), ...	6,875
Hay of vetch and oats (73.65 per cent. dry matter), ...	4,980

at the rate of 5,000–6,000 pounds of hay per acre.

Analysis of the material collected July 2 showed the following composition: —

	Per Cent.
Moisture at 100° C,	80.88
Dry matter,	19.12
	100.00

Analysis of Dry Matter.

Crude ash,	4.48
" fibre,	27.78
" fat,	2.62
" protein,	22.56
Nitrogen-free extract matter,	42.56
	100.00

July 21 the field was again ploughed and harrowed, and on the 23d was sown to Hungarian grass, which began to appear above ground July 28. Its growth was very materially affected by the dry weather. The crop was cut for feeding from September 25 to October 16, the total weight obtained being 4,456 pounds, having an average of 60 per cent. of dry matter.

Conclusions.

From the above figures it will be seen that the practice of introducing early-maturing mixed crops like vetch and oats in connection with valuable second crops like Hungarian, etc., deserves serious attention, on account of their superior fitness for dairy stock.

8. FIELD EXPERIMENTS TO STUDY THE EFFECT OF PHOSPHATIC SLAG AND NITRATE OF SODA AS COMPARED WITH GROUND BONE ON THE YIELD OF OATS AND CORN.

East Field.

The field used for this experiment is situated south of the orchard and of the centre roadway. The soil consists of a loam, and has been under careful cultivation for several years. Its management during previous years can be seen from preceding annual reports.

1894.—During that season the operations on the field were as follows. (See accompanying diagram.) One acre on the upper (eastern) side was fertilized with:—

PLAT I. { 600 pounds of fine-ground bone and
200 pounds of muriate of potash.

The remaining portion (1.8 acres) was fertilized at the rate of:—

PLAT II. { 800 pounds of odorless phosphate,
200 pounds of muriate of potash, and
200 pounds of nitrate of soda per acre.

This corresponds per acre to:—

	No. 1 (Bone).	No. 2 (Phosphate).
Potassium oxide,	104	104
Phosphoric acid,	131	166
Nitrogen,	24	31

Composition of Fertilizer Applied.

	PER CENT.		
	Nitrogen.	Phosphoric Acid.	Potassium Oxide.
Ground bone,	4.09	21.86	–
Odorless phosphate,	–	20.84	–
Muriate of potash,	–	–	52.20
Nitrate of soda,	15.79	–	–

Cost of Fertilizers.

	Per Acre.
Ground bone and muriate of potash, ...	$12 40
Odorless phosphate, nitrate of soda and muriate of potash, .	15 70

April 6 the odorless phosphate was applied to the lower portion of the field. The field was ploughed April 20–23. April 27 the remainder of the fertilizer was applied, and oats were sown on one acre set off at the north end of the field. May 5 the oats began to come up.

Height of Oats.

[Inches.]

June 5, ...	10
June 18, ...	19
June 26, ...	24

The oats began to head out June 25, and on July 25 they were cut, yielding as follows: —

Upper Part (Bone and Muriate), .35 Acre.

	Per Plat.	Per Acre.
Total weight when threshed (pounds), . . .	760	2,171
Grain (pounds), ...	186	531

Lower Part (Odorless Phosphate, etc.), .65 Acre.

	Per Plat.	Per Acre.
Total weight when threshed (pounds), . . .	2,120	3,261
Grain (pounds), ...	570	876

The remaining portion of the field was planted to corn (Pride of the North) on May 15; May 26 the corn was coming up. The field was cultivated and hoed June 8 and

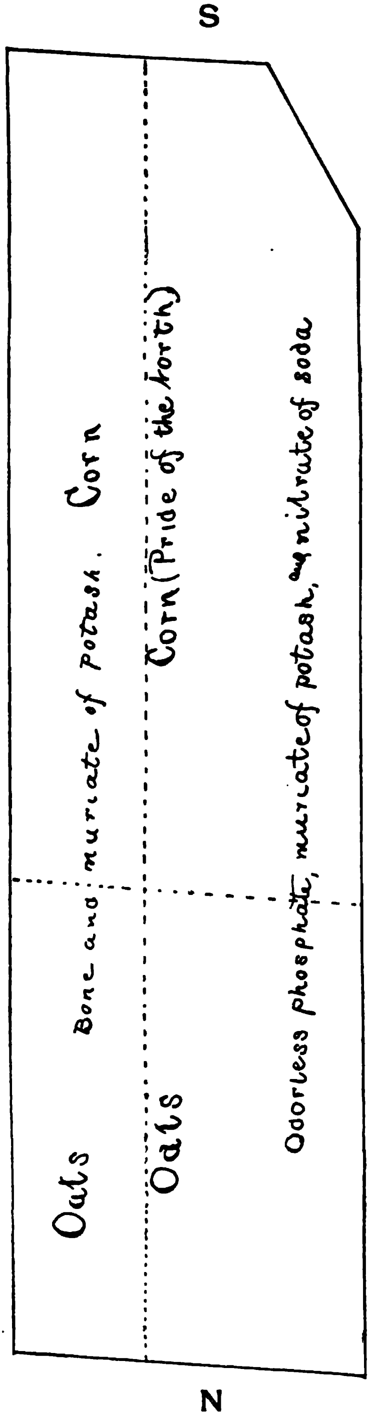
21 and July 2 and 11. August 29 the corn was cut for silage, yielding as follows: —

The upper part (bone and muriate), .7 acre, yielded 11,406 pounds, or 16,294 pounds per acre; the lower part (odorless phosphate, etc.), 1.2 acres, yielded 24,730 pounds, or 20,608 pounds per acre.

Summary of Yield (1894).

[Pounds.]

	PER ACRE.	
	Plat 1 (Bone, etc.).	Plat 2 (Odorless Phosphate, etc.).
Oats (grain),	531	876
Oats (straw),	1,640	2,385
Corn,	16,294	20,608


S
Oats
Bone and muriate of potash.
Corn
Oats
Corn (Pride of the North)
Odorless phosphate, muriate of potash, and nitrate of soda
N

Scale, 100 feet to 1 inch.

9. EXPERIMENTS WITH PERMANENT GRASS LANDS (MEADOWS).

The meadows under consideration comprise an area of about 9.6 acres. The entire field up to 1886 consisted of old, worn-out grass lands, overrun with a worthless growth on its more elevated portion and covered with weeds and sedges in its lower portion. The improvement of the land by underdraining was commenced in 1886 and continued during the succeeding years. For details of the work see ninth and tenth annual reports (1891–92).

In the spring of 1893 a change was made in the *mode* of manuring of the grass plats. It was decided to study the effect of *a rotation of the three kinds of manures previously applied* upon the fields. The area was divided into three plats, Plat 1 (3.97 acres) being the area heretofore covered by plats 1 and 2; Plat 2 (2.59 acres) and Plat 3 (3 acres) correspond to plats 3 and 4 of previous years. The system of manuring adopted was as follows: —

Plat 1. — Wood ashes, 1 ton to the acre.
Plat 2. — Barn-yard manure, 8 tons per acre.
Plat 3. — Six hundred pounds fine-ground bone and 200 pounds muriate of potash per acre.

1894. — The above arrangement of plats was continued during the present season, and the fertilizers were applied in the same proportion to the same plats.

Yield of Hay (1894).

	PER PLAT.			PER ACRE.		
	Plat 1.	Plat 2.	Plat 3.	Plat 1.	Plat 2.	Plat 3.
First cut, ...	9.94	7.41	7.62	2.50	2.86	2.54
Second cut, ...	1.41	1.33	.56	.37	.51	.18
Total yield, . . .	11.35	8.74	8.18	2.87	3.37	2.72

Yield of Hay (1889–94).

	RATE PER ACRE (TONS).		
	First Cut.	Second Cut.	Total
1889.			
Plat 1, barn-yard manure, 18 tons to acre,	2.73	1.14	3.87
Plat 2, barn-yard manure, 8 tons to acre,	2.38	1.21	3.59
Plat 3, 600 pounds steamed bone and 200 pounds muriate of potash,	2.50	1.03	3.56
1890.			
Plat 1, barn-yard manure, 14 tons to acre,	3.80	1.00	4.80
Plat 2, barn-yard manure, 11 tons to acre,	3.25	1.34	4.59
Plat 3, as in 1889 (bone and muriate of potash),	3.00	.73	3.73
Plat 4, wood ashes, 1 ton to acre,	2.23	.68	2.91
1891.			
Plat 1, barn-yard manure, 8 tons to acre,	3.26	.72	3.98
Plat 2, barn-yard manure, 6 tons to acre,	2.99	.72	3.71
Plat 3, as in 1890 (bone and muriate of potash),	2.32	.51	2.83
Plat 4, as in 1890 (wood ashes),	2.32	.51	2.83
1892.			
Plat 1, as in 1891 (barn-yard manure),	2.77	1.04	3.81
Plat 2, as in 1891 (barn-yard manure),	2.70	.98	3.68
Plat 3, as in 1891 (bone and muriate of potash),	2.33	.64	2.97
Plat 4, as in 1891 (wood ashes),	2.18	1.02	3.20
1893.			
Plats 1 and 2, wood ashes, 1 ton to acre,	2.28	.77	3.05
Plat 3, barn-yard manure, 8 tons to acre,	2.62	.86	3.48
Plat 4, 600 pounds ground bone and 200 pounds muriate of potash to acre,	1.94	.64	2.58
1894.			
Plats 1 and 2, wood ashes, 1 ton to acre,	2.50	.37	2.87
Plat 3, barn-yard manure, 8 tons to acre,	2.86	.51	3.37
Plat 4, 600 pounds ground bone and 200 pounds muriate of potash to acre,	2.54	.18	2.72

The past season was marked by a severe drought, beginning with the month of July and extending into the fall, which affected the yield of the crop (second cut) to a serious extent.

10. ORCHARD. EXPERIMENTS WITH HOME-MADE STABLE MANURE, UNLEACHED WOOD ASHES AND VARIOUS MIXTURES OF FERTILIZING MATERIALS ON THE GROWTH AND YIELD OF SEVERAL PROMINENT VARIETIES OF FRUIT TREES (APPLES, PEARS, PEACHES AND PLUMS).

The land used for the experiments described below is situated along the east side of the station farm. It borders on the west on a meadow, and on the eastern side is separated from a natural grove by a private road thirty-five to forty feet wide.

The soil consists of a somewhat sandy loam, with indications of light springs in various parts of the field. The more prominent springs have been connected by drain pipes with the main drain of the adjoining meadow since the experiment began.

The entire field slopes gently and quite uniformly from east to west. Corn and grasses represent in the main the crops raised upon the ground in years preceding 1887.

The inferior yield and character of the crops of later years raised upon the land pointed towards an indifferent management, as far as the selection of crops and of manure is concerned. To destroy weeds and other objectionable local growths, it became advisable to introduce a thorough system of drill cultivation, which was begun in 1888.

In 1889 a series of field experiments with different manures was instituted, which has been continued up to the present time. The system of manuring employed from 1888 to 1894 is given below: —

Fertilizer applied Each Year from 1889 to 1894.

Plat I. — Home-made mixed barn-yard manure, 18,000 pounds (rate of 10 tons per acre).

Plat II. — Wood ashes, 1,800 pounds (rate of 1 ton per acre).

Plat III. — No fertilizer.

Plat IV. — Ground bone, 540 pounds (rate of 600 pounds per acre); muriate of potash, 180 pounds (rate of 200 pounds per acre).

Plat V. — Ground bone, 540 pounds (rate of 600 pounds per acre); sulphate of potash and magnesia, 360 pounds (rate of 400 pounds per acre).

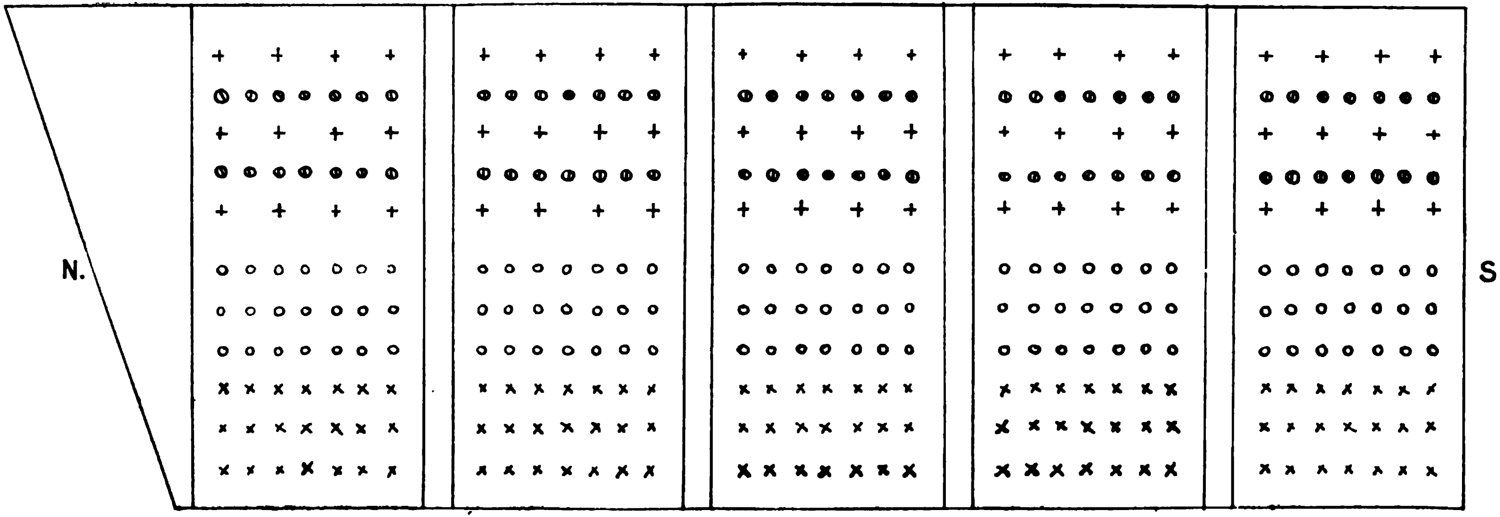
The details of the management of the field under discussion may be found in our annual report for 1893. In 1890 the main portion of the northern part was laid down as an orchard, a number of prominent varieties of apples, pears and peaches being set out in the order indicated in the accompanying diagram of the field. To these a number of varieties of plum trees was added in the fall of 1893. The system of cultivation was kept up as indicated in previous reports, barley and corn being raised (between the trees) in 1889; vetch and oats, Scotch tares and soja bean in 1890; barley and oats in 1891; Canada peas and oats, soja bean and Dent corn in 1892; vetch and oats, soja bean and barley in 1893; and in the fall of 1893 the orchard was seeded down to rye and grass. The space about four feet wide around the trees will be kept free from growth by means of the hoe, while the system of manuring as above will be continued for years to come, to ascertain the effect, if any, of the different systems of manuring on the growth and healthfulness of the stated varieties of trees under corresponding circumstances. The fertilizer will be applied as a top-dressing to each plat either in the spring or fall, as circumstances may advise.

Arrangement of Trees in Plats of Orchard.

Each plat contains the following varieties of trees, beginning at the south. The rows run east and west, and there are three trees in each row of apples, pears and peaches, and two in a row in case of plums: —

Apple.	Peach	Pear.	Plum.
Gravenstein,	Early Rivers,	Flemish Beauty,	German Prune.
	Beer's Smock,	Seckel,	German Prune.
Baldwin,	Coolidge Favorite,	Sheldon,	Green Gage.
	Early Crawford,	Bartlett,	Imperial Gage.
Roxbury Russet,	Old Mixon,	D'Anjou,	Jefferson.
	Stump of the World,	Lawrence,	Lombard.
Rhode Island Greening,	Late Crawford,	Buerre Bosc,	-

Orchard, 1894.



Scale 100 feet to 1 inch. + Apple. o Peach. × Pear. ⊖ Plum.

11. OBSERVATIONS IN THE VEGETATION HOUSE.

1. Observations with different forms of potash, phosphoric acid and nitrogen on garden crops (C. A. GOESSMANN).
2. Experiments with Philadelphia tankage and dried blood as a nitrogen source for the raising of winter grain (rye) (C. A. GOESSMANN).
3. Leather refuse, — its value in agriculture (J. B. LINDSEY).

From preceding descriptions of experiments carried on upon the fields of the station it will be noticed that our attention has been turned of late to a special study of the effect of different forms of nitrogen and potassium oxide on the growth of a series of prominent fruit and garden crops. The results of three years' observations regarding the latter are already reported in detail upon preceding pages (Field C).

To explain the striking differences noticed in the yields of some of those crops, in particular lettuce and tomatoes, when raised with the assistance of either muriate or sulphate of potash (upon Field C), it seemed advisable for confirmation of the results to transfer the investigations to the vegetation house, where, under better-defined circumstances, the special effects of the kind and form of the various articles of plant food supplied, as well as the most suitable quantity of each (nitrogen, potassium oxide and phosphoric acid), could be more clearly demonstrated. General observations with fertilizers in the vegetation house began four years ago.

1. OBSERVATIONS WITH DIFFERENT FORMS OF POTASH, PHOSPHORIC ACID AND NITROGEN ON GARDEN CROPS.

BY C. A. GOESSMANN.

The first systematic attempt in the above-stated direction was made during the winter of 1892–93. The soil used in the vegetation house during that year was a sandy loam taken a few feet below the surface from a locality which at no time had received an additional supply of manurial matter from an outside source. It was sent through a screen before being used, to remove coarse vegetable matter (roots, etc.). *Lettuce* and *New Zealand spinach* were used for the observation.

The relative proportion of fertilizer applied was: of potassium oxide, 3 parts; of phosphoric acid, 1 part; and of nitrogen, 1 part. The percentage of the different ingredients added to the soil was as follows: —

	Per Cent.
Potassium oxide,	.00026
Phosphoric acid,	.00009
Nitrogen,	.00009

The lettuce seeded in the boxes containing muriate of potash as the potash source proved a complete failure, as the young plants attained a height of only one and one-half inches, the color of the leaves changed into various shades of red, and growth ceased. In the other boxes the results were less striking, but the most satisfactory growth was obtained in those boxes in which sulphate of potash or sulphate of potash-magnesia furnished the source of potash.

Less marked was the difference in growth of the New Zealand spinach, the plants growing in the boxes containing muriate of potash being at first less vigorous; the difference in the yield at the close of the experiment was not so marked, except in regard to the time required to reach perfection. The most striking fact noticed with regard to these preliminary experiments was the apparently injurious effect of muriate of potash on lettuce. This result induced me to repeat the experiment in the vegetation house during the winter of 1893–94 (see annual report).

The soil turned to account during that season was obtained two feet below the surface of an abandoned pasture, which had not received any addition of manurial matter from an outside source for many years. The soil was screened, thus being freed from coarse material of every description. It consisted of a light loam. Twelve boxes (marked from 1 to 12), corresponding in size to those of the previous year (32 by 32 by 8 inches), were employed, each containing about three hundred pounds of the soil, being filled to within one inch of the top. To secure a thorough mixing of the fertilizer and soil, they were worked together with the shovel and the mixture sent twice through the screen. The addition of the fertilizer to the soil was made two weeks in advance of the seeding. A greater variety of fertilizer mixtures was turned to account, including those of the preceding year. The potassium oxide was furnished by muriate of potash (1, 2 and 3), sulphate of potash (4, 5, 6 and 12), carbonate of potash-magnesia (7, 8, 9 and 10) and phosphate of potash (11). The phosphoric acid was supplied by dissolved boneblack (1, 2, 3, 4, 5, 7, 8 and 9), odorless phosphate (6), double superphosphate (10), phosphate of potash (11) and phosphate of ammonia (12). The nitrogen was added in the form of nitrate of soda (1, 4, 7, 10 and 11), sulphate of ammonia (2, 5 and 8), phosphate of ammonia (12) and organic nitrogen (dried blood) (3, 6 and 9). The relative ratio of essential fertilizing constituents applied was four parts potassium oxide, one part phosphoric acid and one part nitrogen. The percentage of the essential elements of plant food applied to the soil in boxes 1–9 (inclusive) was as follows: —

	Per Cent.
Potassium oxide,	.0004
Phosphoric acid,	.0001
Nitrogen,	.0001

The proportions for the remaining boxes are given below: —

	Per Cent.		
	Box 10.	Box 11.	Box 12.
Potassium oxide,	.0004	.0004	.0004
Phosphoric acid,	.0004	.0004	.0004
Nitrogen,	.0001	.0002	.0001

Following is a statement of the fertilizer mixtures used:—

Box 1.

128 grams muriate of potash.
106 grams dissolved bone-black.
106 grams nitrate of soda.

Box 2.

128 grams muriate of potash.
106 grams dissolved bone-black.
78 grams sulphate of ammonia.

Box 3.

128 grams muriate of potash.
100 grams dissolved bone-black.
155 grams dried blood.

Box 4.

128 grams sulphate of potash.
106 grams dissolved bone-black.
106 grams nitrate of soda.

Box 5.

128 grams sulphate of potash.
106 grams dissolved bone-black.
78 grams sulphate of ammonia.

Box 6.

128 grams sulphate of potash.
90 grams odorless phosphate.
155 grams dried blood.

Box 7.

360 grams carbonate of potash-magnesia.
106 grams dissolved bone-black.
106 grams nitrate of soda.

Box 8.

360 grams carbonate of potash-magnesia.
106 grams dissolved bone-black.
78 grams sulphate of ammonia.

Box 9.

360 grams carbonate of potash-magnesia.
100 grams dissolved bone-black.
155 grams dried blood.

Box 10.

136 grams double superphosphate.
360 grams carbonate of potash-magnesia.
106 grams nitrate of soda.

Box 11.

200 grams phosphate of potash.
212 grams nitrate of soda.

Box 12.

145 grams phosphate of ammonia.
128 grams sulphate of potash.

Analyses of chemicals used in compounding the above mixtures will be found below: —

	Potassium Oxide.	Phosphoric Acid.	Nitrogen.
	Per Cent.	Per Cent.	Per Cent.
Muriate of potash, ...	46.00	-	-
Sulphate of potash, ...	50.20	-	-
Potash-magnesia sulphate, . .	24.32	-	-
Carbonate of potash-magnesia, . .	18.48	-	-
Phosphate of potash, ...	32.56	35.70	-
Dissolved bone-black, . . .	-	13.88	-
Odorless phosphate, ...	-	18.42	-
Double superphosphate, . . .	-	47.80	-
Phosphate of ammonia, . . .	-	43.86	10.37
Dried blood, ...	-	4.02	10.00
Nitrate of soda, ...	-	-	14.28
Sulphate of ammonia, . . .	-	-	19.59

A greater variety of garden vegetables was selected for trial. Each box was planted on October 11 with seed of the following: —

Lettuce, variety Hanson.
Spinach, variety New Zealand.
Beets, variety Egyptian.
Tomato, variety Essex Hybrid.

The boxes were treated similarly with regard to temperature and time of watering. To control the experiment, part of the vegetation house was turned to account to raise the same varieties of vegetables in the same soil, properly manured with vegetable compost from a successfully managed hot-bed. On October 17 the lettuce and spinach appeared, and by October 20 the remaining seeds had sprouted. The following notes relating to the different garden vegetables on trial may not be without interest in this connection, although still of a preliminary character: —

Lettuce. — The seed germinated well in all cases except with box 12, in which the number was somewhat scanty. During the first two or three weeks of growth the difference in the boxes was not very marked, although on November 20 1, 2 and 3 were noted as being generally of poorer quality than the others, with 4, 5 and 6 next. Nos. 2 and 5 were the poorest in their respective groups in which the nitrogen was furnished by ammonia salts. In boxes 8 and 12 the same failure was noticed.

The lettuce was removed from 9 and 10 January 10, having made a very satisfactory growth, and on January 20 from 7 and 8, also with a good growth.

Beets. — The seed germinated well in all cases, and during the first part of the growing period no very great differences were observed in the general appearance of the various boxes. The plants in 7, 8, 9, 10 and 11 proved the most satisfactory, being removed January 31.

Spinach. — This crop grew better in proportion in all the boxes than either of the others on trial. In 1, 2 and 3 it made a fair growth, although not as vigorous as in the remaining boxes; 4, 5 and 6 showed a more vigorous and rapid growth, while 7, 8 and 9 proved to be still more vigorous. Boxes 10 and 11 showed a corresponding relative increase in growth, the plants being removed on January 3, when in bloom.

Tomatoes. — The growth of the tomatoes in 1, 2 and 3 was less satisfactory than in most of the others. The degree of growth under the influence of different fertilizers may be noticed from the following table, expressing the heights of the plants at different periods of the observation: —

Height of Tomato Plants.

[Inches.]

DATE.	BOXES.											
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
December 5, . . .	5½	2½	8	8	5	5	6½	8½	8	13½	9	8½
December 19, . . .	9½	6½	7	18	10	11½	11	14	14	24	21	21
January 9, . . .	26	10	25	36	22	22	28	31	32	45	44	43

The plants came in bloom as follows: in box 10, on December 18; in box 11, on December 20; in box 12, on December 23; in boxes 4, 5, 6, 7, 8 and 9, on January 1; and in boxes 1 and 3, on January 3. The plants in box 2 came in bloom February 15.

Fruit was formed first on the plants in box 10, noticed on January 17. It first appeared in box 12 on January 18; in boxes 4 and 9 on January 21; in box 3 on January 24; in box 1 on January 27; in box 8 on February 5; and in box 7 on February 28.

Fruit ripened in box 10 on February 20; in boxes 3, 4 and 12, on February 28; in box 9, on March 1; and in box 8, on March 7.

The plants grown in the soil manured with vegetable compost, as a sort of control experiment, made a very vigorous and healthy growth, but blossomed late and had formed no fruit up to March 8, although retaining their promising appearance.

Conclusions.

Lettuce did best in boxes 10, 9, 7 and 8; beets did best in boxes, 7, 10, 8, 4 and 11; spinach did best in boxes 10, 11, 7, 8 and 9; tomatoes did best in boxes 10, 12, 4 and 9.

1894–95. — During the past summer the boxes of the vegetation house were removed and replaced by others somewhat larger. The arrangement for sub-irrigation previously used in box 4 gave such good satisfaction that all of the boxes were similarly equipped.

The soil used for filling the boxes was obtained about six inches below the surface of land which had not been under cultivation for a considerable period. This soil was carefully screened, to remove coarse particles. Each box received about seven hundred and fifty pounds of the earth, to which the fertilizer had been applied and carefully mixed before filling in. The proportion of essential fertilizing ingredients applied to the soil is as follows: —

Boxes 1, 2, 3, 4, 5, 6, 7 and 8.

	Per Cent.
Potassium oxide,	.0056
Phosphoric acid,	.0014
Nitrogen,	.0014

Boxes 9, 10, 11, 12, 14 and 15.

	Per Cent.
Potassium oxide,	.0056
Phosphoric acid,	.0056
Nitrogen,	.0014

Below is given a statement of the various fertilizer mixtures employed, the amounts stated being for one thousand pounds of soil: —

Box 1.

512 grams muriate of potash.
424 grams dissolved bone-black.
620 grams dried blood.

Box 2.

512 grams muriate of potash.
424 grams odorless phosphate.
620 grams dried blood.

Box 3.

512 grams sulphate of potash.
424 grams bone-black.
620 grams dried blood.

Box 4.

512 grams sulphate of potash.
424 grams odorless phosphate.
620 grams dried blood.

Box 5.

1,440 grams potash-magnesia carbonate.
136 grams double superphosphate.
620 grams dried blood.

Box 6.

1,440 grams potash-magnesia carbonate.
424 grams odorless phosphate.
620 grams dried blood.

Box 7.

512 grams sulphate of potash.
136 grams double superphosphate.
424 grams nitrate of soda.

Box 8.

1,440 grams potash-magnesia carbonate.
136 grams double superphosphate.
424 grams nitrate of soda.

Box 9.

544 grams double superphosphate.
1,440 grams potash-magnesia carbonate.
424 grams nitrate of soda.

Box 10.

580 grams phosphate of ammonia.
512 grams sulphate of potash.

Box 11.

800 grams phosphate of potash.
312 grams sulphate of ammonia.

Box 12.

544 grams double superphosphate.
312 grams sulphate of ammonia.
512 grams muriate of potash.

Box 13.

100 pounds compost.

Box 14.

580 grams phosphate of ammonia.
512 grams sulphate of potash.

Box 15.

800 grams phosphate of potash.
312 grams sulphate of ammonia.

Box 16.

100 pounds compost.

The analyses of the chemicals used in compounding the above mixture are given on a preceding page. The analyses of the soil used in filling the boxes, and of the compost applied (13 and 16), will be found below: —

	Soil.	Compost.
Moisture at 100° C.,	7.610	25.750
Phosphoric acid,	.195	.432
Potassium oxide,	.233	.375
Nitrogen,	.065	.458
Organic and volatile matter,	11.380	41.570
Insoluble matter,	85.800	55.150

The boxes were planted October 11 and 12 with the following varieties of vegetables: —

Tomato (the Lorillard).
Turnip (Early American Red Top).
Lettuce (Rawson's New Hot-house).

February 1, tomatoes are looking best in boxes 9, 10, 11 and 8, in the order named; fruit has set on 9 and 10, also on 3 and 4, although the plants have not made a very stocky growth. Turnips are developed most in boxes 13, 16, 14, 15 and 11, in the order named; 9, 10, 2, 3, 4 and 7 have made considerable leaf growth, but have not much root development.

Following is given a summary of results to April 1, 1895. The detailed statement must of necessity be left for future presentation.

Turnips.

[Harvested Feb. 21, 1895.]

	Number of Roots.	Average Diameter of Roots.	Total Weight of Roots.	Total Weight of Leaves.	Average Length of Leaves.
Box 1,	4	2.7	14.00	48.00	17.25
Box 2,	4	2.6	16.00	37.00	14.50
Box 3,	5	2.5	18.00	44.00	14.60
Box 4,	5	2.5	20.00	46.00	15.80
Box 5,	-	-	-	-	-
Box 6,	-	-	-	-	-
Box 7,	4	2.7	17.50	48.00	15.00
Box 8,	-	-	-	-	-
Box 9,	5	1.7	7.00	33.00	13.40
Box 10,	4	2.1	8.50	29.00	15.50
Box 11,	4	2.9	26.00	42.00	17.00
Box 12,	3	2.0	7.50	31.00	14.00
Box 13,	4	4.3	60.50	25.50	15.75
Box 14,	4	4.3	57.00	50.00	17.25
Box 15,	7	3.8	48.00	64.00	16.25
Box 16,	4	4.0	45.00	21.00	14.75

Roots in boxes 5, 6 and 8 have not been harvested.

Tomatoes.

[Summary of observations to April 1, 1895.]

	In Bloom.	Fruit Set.	Ripe.		In Bloom.	Fruit Set	Ripe.
Box 1,	March 25.	-	-	Box 9,	Jan. 7.	Jan. 20.	March 15.
Box 2,	March 20.	April 2.	-	Box 10,	Jan. 1.	Jan. 20.	March 10.
Box 3,	Jan. 6.	Jan. 22.	-	Box 11,	Jan. 4.	Feb. 1.	March 26.
Box 4,	Jan. 8.	March 5.	-	Box 12,	Jan. 20.	March 5.	March 12.
Box 5,	April 2.	-	-	Box 13,	Jan. 4.	March 1.	-
Box 6,	April 2.	-	-	Box 14,	Jan. 10.	March 1.	-
Box 7,	Feb. 7.	April 1.	-	Box 15,	Jan. 5.	March 20.	-
Box 8,	Jan. 15.	March 1.	-	Box 16,	Jan. 8.	March 1.	-

2. EXPERIMENTS WITH PHILADELPHIA TANKAGE AND DRIED BLOOD AS A NITROGEN SOURCE FOR THE RAISING OF WINTER GRAIN (RYE).

BY C. A. GOESSMANN.

1893–94. — The experiments described below were carried on for the purpose of comparing the value of dried blood and Philadelphia tankage as a nitrogen source for the raising of winter rye. The soil used in the experiment was obtained from a locality not under cultivation, and was carefully screened before use. Six boxes were filled, each with about seventy-five pounds of the earth.

Boxes 1 and 4 were fertilized with 180 grams of the following mixture: —

	Parts.
Double superphosphate,	40
Muriate of potash,	100
Dried blood,	100

Boxes 2 and 3 were fertilized with 180 grams of the following mixture: —

	Parts.
Double superphosphate,	40
Muriate of potash,	100
Philadelphia tankage,	100

The other two boxes received no fertilizer addition.

Sept. 21, 1893, winter rye was sown in the boxes. This began to appear above ground September 25, and October 12 the plants were thinned to five in a row, three rows in a box. During the winter the boxes were kept in the unheated portion of the vegetation house, and, to get as nearly as possible the outside conditions, snow was placed on the boxes at intervals, its melting furnishing the only water the boxes received during the winter. At the opening of spring the boxes were again regularly watered, during the summer receiving about four hundred cubic centimeters of water daily. No very striking differences were noticed in the appearance of the fertilized boxes, the average height being about thirty-six inches. The boxes receiving no fertilizer averaged thirty inches in height. The plants were in bloom May 25. They were harvested July 27. They were kept until October 9, when the following weights were taken: —

Weight (Grams).

	TANKAGE.		BLOOD.		NOTHING.	
Boxes,	**2.**	**3.**	**1.**	**4.**	**5.**	**6.**
Number of heads,	**41**	**41**	**51**	**41**	**25**	**18**
Total weight,	**10.67**	**13.10**	**12.50**	**9.07**	**8.25**	**5.02**
Number containing grain,	**24**	**32**	**26**	**23**	**21**	**13**
Number empty heads,	**17**	**9**	**25**	**18**	**4**	**5**
Weight of straw,	**22.17**	**22.57**	**33.45**	**22.80**	**16.70**	**11.60**

1894–95. — The experiments with winter crops were continued during the winter of 1894–95, as follows: —

Ten boxes were filled with the same kind of earth used in the beds of the hot-house, about 100 pounds being used per box, together with the following fertilizer mixtures: —

Box 1.

7.68 grams sulphate of potash.
24.38 grams bone-black.
24.38 grams nitrate of soda.

Box 2.

7.68 grams sulphate of potash.
24.38 grams odorless phosphate.
24.38 grams nitrate of soda.

Box 3.

7.68 grams sulphate of potash.
24.38 grams bone-black.
18.72 grams sulphate of ammonia.

Box 4.

7.68 grams sulphate of potash.
24.38 grams odorless phosphate.
18.72 grams sulphate of ammonia.

Box 5.

7.68 grams sulphate of potash.
24.38 grams bone-black.
40.22 grams dried blood.

Box 6.

7.68 grams sulphate of potash.
24.38 grams odorless phosphate.
40.22 grams dried blood.

Box 7.

7.68 grams sulphate of potash.
24.38 grams bone-black.
51.16 grams Philadelphia tankage.

Box 8.

7.68 grams sulphate of potash.
24.38 grams odorless phosphate.
51.16 grams Philadelphia tankage.

Box 9.

7.68 grams sulphate of potash.
24.38 grams bone-black.
56.64 grams leather refuse.

Box 10.

7.68 grams sulphate of potash.
24.38 grams odorless phosphate
56.64 grams leather refuse.

The chemical composition of the above fertilizing ingredients can be ascertained from the table on page 277. The Philadelphia tankage contained seven and one-half per cent. nitrogen.

October 2, crops were planted in the boxes as follows: —

Boxes 1 and 2, winter rape.
Boxes 3 and 4, winter vetch.
Boxes 5, 6, 7, 8, 9 and 10, winter rye.

The seed germinated well and the plants made a good growth before winter, being left in the cold house and covered with snow during the winter season, to imitate as nearly as possible the outside conditions.

3. Leather Refuse, — its Value in Agriculture.*

By J. B. Lindsey.

During the past few years claims have been made at various times that large quantities of leather shavings and the like have found their way into the so-called commercial fertilizers that are so widely used by the farmers of the United States. The writer has no means of knowing whether this claim is true or not. It should be the object of the fertilizer manufacturer to utilize all kinds of waste products that possess distinct manurial value. By so doing he not only benefits himself, but the farmer as well.

It was very early assumed from its chemical character, without any exact experiments upon which to base the assumption, that leather refuse would yield its nitrogen as plant food very slowly, if at all.

I. Historical Review.

1. Methods employed to make the Nitrogen available to Growing Plants.

The first method suggested, so far as the writer has been able to ascertain, was that prescribed by F. O. Ward † of England, in 1857, for turning to account woollen rags, wool, silk and leather clippings. The process as described was as follows: the refuse was introduced into an ordinary autoclave digester, and there kept for about three hours, surrounded by steam heated to a pressure of from three to five atmospheres. Wool required a higher temperature than leather, and silk than wool. The materials condensed a portion of the steam and absorbed its heat. This joint action converted the animal matter into a friable substance, which, however, still retained its original form and aspect. It was then ground fine, sifted and bagged. "The details of the process, the fuel and labor-saving arrangements that have been learned, point by point, by costly manufacturing experience, cannot," says Ward, "with propriety be divulged." The final product is described as a dark-colored powder. The nitrogen in the finished product is said to exist to a small extent as ready formed ammonia, being in combination with ulmic and humic acids developed during the process. It was stated at the time that this manufacturing process was carried on at large works on the Thames. The material for the most part was sold to manure manufacturers, who used it as an ingredient of their several fertilizing compounds, and it was "used by many farmers who are not aware of the fact." Ward says that, "while this material is not as active as some other forms of organic nitrogen, it possessed distinct value as a fertilizer."*

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* A portion of this article has already appeared in Agricultural Science, Vol. 8, Nos. 2 and 3, 1894.

† Report by the Juries of the International Exhibition, 1862. Reporter, A. W. Hoffman. Repertory of Patent Inventions, August, 1857, page 137.

Edw. Toynbec,† in 1858, also described a process whereby leather and wool waste could be cooked in sulphuric acid, and be made more available as a fertilizer. He said that "to one centner of sulphuric acid four or five centners of wool or leather waste could be added." The writer does not see how such a large amount of leather could be added to the acid, as will be shown further on. L. Meyer ‡ speaks of dissolving all such refuse substances in warm sulphuric acid, and neutralizing the moist mass with bone.

A. Lipowitz § notes the fact that the Posner fertilizer factory utilizes all such kinds of waste as have already been referred to.

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* The writer does not know whether this process is still in operation in England for utilizing the leather, wool and silk wastes.

† Repertory of Patent Inventions, 1858, page 389. Jahresbericht Agric. Chem., 1859.

‡ Jahresbericht Agric. Chem., 1859, 228.

§ Allgem. Zeitung für deutsche Land. und Forstwirthe, 1859, 153.

Runge [*] speaks of rendering leather and wool more available by dissolving them in a mixture of Glauber's salt and quick-lime. This chemist manufactured a fertilizer upon a large scale from these materials.

Reichardt [†] describes his method of subjecting the leather refuse to steam pressure, and then drying it quickly. After such a treatment he found 15.75 per cent. of the material to be soluble in boiling water, and that, after standing for some time, 20 per cent. could be dissolved. By treating the dry leather that had been subjected to steam with 20 to 40 per cent. sulphuric acid, he was enabled to dissolve from 22 to 29 per cent. of the leather in water. With a five per cent. solution of crystallized soda, 28.8 per cent. could be brought into solution. He therefore concluded that the best method was to subject the leather to the action of a weak soda solution.

Coignet's [‡] method was reported in 1874 by H. Mangon. Briefly stated, it is as follows: the refuse material is placed in a room having a cubic area of 20 meters. Directly outside of the room is a coke oven, connected with a chimney that has an opening into the room containing the material to be treated. Into this chimney are conducted jets of steam, so that the room is heated from 150° to 160° C. for several hours by this moist chimney air. Under these conditions the leather swells somewhat, and becomes dark, brittle, and can easily be rubbed to a powder.

Storer [§] says: "It is evidently with reference to this process that the statement has recently been made that certain manufacturers of fertilizers at Paris devote themselves particularly to the preparation of torrefied wool, horn, leather and even bone, the leather having first been steamed strongly to remove oil and gelatine."

L'Hote [‖] describes a method whereby such waste material as wool, leather, etc., can be converted into sulphate of ammonia. He suggests dissolving the material in a ten per cent. solution of caustic soda in the cold. The substances will be partly dissolved, or their structure more or less destroyed. The jelly-like mass is then mixed with caustic lime till it becomes of a doughy consistency. It is then brought into iron retorts, and heated at first at as low a temperature as possible, in order to prevent the dissociation of the ammonia, which is caught in sulphuric acid. After the gas has been nearly driven off, the retorts are subjected to red heat. At the end of the operation a white powdery substance is left behind, consisting of carbonate of soda and caustic lime. By cooking this substance with water, caustic soda is formed and can be again utilized. By this method all the nitrogen is obtained. The resulting sulphate of ammonia is somewhat colored.

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[*] Jahresbericht Agric. Chem., 1865.

[†] Zeitschrift für deutsche Landwirtschaft, 1865, 136. Jahresbericht Agric. Chem., 1865.

[‡] Organ der Vereinf. Rübenz. Industrie in Œster-Ungarn, 1874, 32. Jahresbericht Agric. Chem., 1873-1874, 37.

[§] *Agriculture* I., 382.

[‖] Centralblatt für Agric. Chem., 5, 258. Illustrirte Landw. Zeitung, 1874, No. 2, 18.

For utilizing leather Rümpler* suggests the following method: in lead or iron jacketed kettles, sulphuric acid of 50° B. is heated very hot, and leather stirred in till a dark-brown fluid is obtained. This fluid is then used to dissolve the phosphate of lime. He remarks that "the nitrogen is saved, and without doubt is much more available from the fact that the tannin is destroyed."

Erhardt† suggests that such refuse material be slowly burned in closed ovens, and the gas collected in moist muck till the latter becomes saturated. This muck mixed with superphosphate gave, he says, a quick-acting manure.

Deherain‡ says that this leather refuse can be dissolved in sulphuric acid, and the excess of acid neutralized with phosphate of lime. In this way he claims a very active fertilizer can be obtained at a low cost.

The writer understands that this latter method has been in quite general use for many years by European manufacturers. Not only has leather been thus treated, but also a great variety of nitrogen-containing refuse materials. American manufacturers also subject various waste materials to the action of sulphuric acid, in order to render them more quickly available.

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* Kaüfliche Düngestoffe. H. Rümpler, 1875 (Thaer Bibliothek).

† Jahresbericht Agric. Chem., 1880, 337.

‡ Deherain, *Chimie Agricole* [1892], 624.

From the many methods suggested for the utilization of leather waste, it is evident that in the older countries, specially England, France and Germany, this material, after having been submitted to some mode of treatment, is quite generally used, to a greater or less degree, in the manufacture of commercial fertilizers.

Petermann * says that "it is well known that certain Belgian and French manufacturers use leather in their products, but that such goods contain, in addition, nitrogen in other forms, such as blood, horn, meal, sulphate of ammonia and nitrate of soda." He further states that the "factories producing this material are numerous, and a considerable quantity is produced annually."

2. *Manurial Value of Prepared Leather Waste.*

The different experiments made to prove the value of leather have been conducted either with untreated finely ground leather, with torrefied leather, or with leather steamed under pressure.

Three different methods have been used in testing the agricultural value of leather: (*a*) by directly testing its fertilizing effect either in pot or plat experiments; (*b*) by artificially digesting it with a pepsin solution; (*c*) by noting the length of time required to nitrify it. The first method is by far the most interesting, and leads to direct results. The other two serve at least to confirm the results obtained by the first method.

A. POT AND PLAT EXPERIMENTS.

Very early experiments are not to be found in literature. The first experiment recorded was made by Ladureau,† and lasted but a single season. He found that 2,500 kilos. of torrefied leather yielded 30,100 kilos. of sugar beets, testing 8.83 per cent. of sugar; and 2,500 kilos. of the same leather plus 200 hectolitres of lime gave 38,600 kilos. of beets, with 10.10 per cent. sugar. The same area of land without leather yielded 20,000 kilos. of sugar beets, testing

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* *Recherches de Chimie et Physiologie* [1885], 144.

† Annales Agron., 1878; *Loc. cit.*, 146.

10.93 per cent. sugar. Petermann remarks on these results as follows: "In spite of the increased yield obtained by using the leather, the experiment was not a success financially, and, further, the beets produced with the aid of the leather were poorer in quality than those without it."

In 1880 Petermann * carried out a series of experiments with ground steamed leather, to test its manurial value. It was very dry and brittle, and contained 7.51 per cent. of nitrogen and 0.81 per cent. of phosphoric anhydride soluble in hydrochloric acid.

The experiments were carried on in the plant house in pots, with oats; in the garden, with the horse bean (*Vicia faba*); and in the field, with sugar beets.

Experiments with Oats in Pots.

Each test was made in duplicate. The soil was what might be called a sandy clay, each pot holding 4,000 grams. The fertilizer was mixed with three-fourths of the soil of each pot. To the soil in each pot were added 0.25 gram of nitrogen, 0.30 gram of phosphoric acid and 0.20 gram of potash.

Results (Average of the Duplicates, expressed in Grams).

	Entire Plant.	Straw.	Chaff.	Grain.
Unmanured,	22.34	15.19	.95	6.20
Series I.				
Nitrogen.				
(*a*) Leather,	34.85	26.65	1.25	6.95
(*b*) Dried blood,	51.91	36.68	1.82	13.41
Series II.				
Nitrogen + Phosphoric Acid.				
(*a*) Leather + precipitated phosphate,	39.98	31.28	1.15	7.50
(*b*) Blood + precipitated phosphate,	51.97	36.45	1.91	13.61

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* *Loc. cit.*, 144 Centrabl. Agric. Chem., **10**, 590.

Series III.

	Entire Plant.	Straw.	Chaff.	Grain.
Nitrogen + Phosphoric Acid + Potash.				
(*a*) Leather + precipitated phosphate + muriate of potash.	30.55	21.90	1.09	7.56
(*b*) Dried blood + precipitated phosphate + muriate of potash.	37.40	29.65	1.82	15.93

In observing the results of the experiments we notice especially, with reference to the grain produced, that the leather did not increase the yield to any appreciable extent over that of the unfertilized pots. When phosphoric acid and potash were applied with the leather a slight increase in the yield of grain was noticed, while in case of the dried blood plus the phosphoric acid and potash the yield was twice that of the unfertilized pot.

Garden Experiments with Horse Beans.

The soil was the same as in the previous experiment. Size of plats, 60 square meters. The fertilizer applied was leather and nitrate of soda. Nitrogen was applied at the rate of 58.5 pounds per acre.

Results per Plat.

	Stems and Pods in Kilos.	Beans in Kilos.	Beans per Acre in Kilos.
Unmanured,	9,869	1,131	37,700
Leather,	12,822	1,178	39,268
Nitrate of soda,	11,465	2,035	67,832

It will be observed that the leather produced only a slight increase in the yield of beans.

Field Experiments with Sugar Beets.

Same soil as in previous experiments. Each plat measured one are. The fertilizer was applied at the rate of 42¼ pounds of nitrogen and 52.8 pounds of phosphoric acid per acre.

Results per Hectare.

	Kilos.	Percentage Increase over Unmanured.
Unmanured,	34,830	-
Soluble phosphoric acid,	34,380	—1.5
Water and citrate soluble phosphoric acid,	34,290	—1.2
Citrate soluble phosphoric acid,	34,380	—1.5
Unmanured,	33,840	-
Leather + soluble phosphoric acid,	37,890	11.9
Leather + water soluble + citrate soluble phosphoric acid.	37,180	10.7
Leather + citrate soluble phosphoric acid,	35,910	6.0
Unmanured,	32,940	-
Nitrate of soda + soluble phosphoric acid,	43,380	28.1
Nitrate of soda + water + citrate soluble phosphoric acid.	42,070	24.2
Nitrate of soda + citrate soluble phosphoric acid,	43,830	29.4

While the leather has shown its effect, it runs far behind the nitrate of soda. Petermann says that from a financial stand-point the leather shows a loss and the nitrate of soda a gain. Of his results the experimenter makes the following résumé: "With horse bean the leather shows practically no influence the first year; with oats and sugar beets an increase is noted, but this is slight when compared with that from blood and nitrate of soda." In a later publication Petermann says that in his experiments from 1880 to 1885 the various forms of nitrogen have shown the following relative worth: 1, nitrate of soda; 2, blood; 3, dissolved wool; 4, ground bone; 5, raw wool; 6, leather.

Deherain * gives the results of the following experiments conducted in the field at Grignon with ground leather. The results with wheat in 1880 and 1881 show the residual effect of the leather applied to potatoes in 1879: —

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* *Chimie Agricole* (1892), 619.

	POTATOES.	WHEAT.			
	1879. Hectolitres.	1880. Grain (Qtm.).*	1880. Straw (Qtm.).	1881. Grain (Qtm.).	1881. Straw (Qtm.).
Unfertilized, ...	224	25.0	37.25	16.4	20.5
Leather, 2,000 kilos., .	295	27.5	40.00	23.4	38.7
Leather, 1,000 kilos., .	277	25.0	38.00	23.0	37.6

Deherain remarks that his experiments make it clear that the leather yields its nitrogen very slowly. He does not state whether the leather used had been steamed, roasted or was untreated.

Müntz † and Girard, in connection with their experiments on the nitrification of various nitrogen-containing organic substances, carried out also a series of field experiments with various nitrogenous materials. Each plat had an area of one are and received 1.25 kilos. of nitrogen the first year, together with the necessary quantity of phosphoric acid and potash. No manure was applied the second year. The soil was light and sandy, being quite favorable to nitrification. The plats were planted with fodder corn during both years.

Fodder Corn grown upon One Are (Dry Matter).

FORM OF NITROGEN.	1888. Kilos.	1889. Kilos.	Average of Both Years.
Nitrate of soda, ...	143	47	190
Dried blood, ...	130	48	178
Roasted horn, ...	123	52	175
Roasted leather, ...	91	61	152
No nitrogen, ...	59	43	102

The above results show that leather, even when roasted, is quite inferior in its action to dried blood and nitrate of soda.

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* Qtm. (quintal metrique) = 100 kilograms.

† Ann. Agron., 17, 289-304; Biedermann's Centralblatt, **20**, 656.

Märcker * gives the following results obtained by Seyffert, at Halle, with cole-rape: —

FORM OF NITROGEN.	Yield in Grams.
No nitrogen,	75.5
Leather,	469.0
Steamed bone meal,	1,572.0
Blood,	1,654.0
Nitrate of soda,	2,607.5

In order to control the above experiment another test was carried out with oats by Julius Albert-Münchenhof: —

Yield.

FORM OF NITROGEN.	Grain (Grams).	Straw (Grams).	Roots (Grams).	Total (Grams).
No nitrogen,	5.2	15.7	14.3	38.2
Nitrate of soda,	48.9	62.6	27.9	139.4
Dried blood,	24.8	44.5	18.5	87.8
Leather,	13.3	22.2	13.6	49.1
Leather, fermented,	21.5	36.4	17.2	75.1

Märcker remarks that leather produced but a slight increase over the unfertilized, and that the quality of the grain was poorest when no nitrogen was used, or when leather was applied.

Dr. Wm. Frear very concisely presents the work done by Storer † as follows: —

Storer tested the manurial value of sheepskin and sole-leather, raw and roasted, on several soils in pots, applying various phosphatic and potassic salts in solution. The crop used was buckwheat. The results were as follows (expressed in weight of total crop in grams): —

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* Jahresbericht Agr. Chemie, 1883, 241.

† Bulletin Bussey Institution, 2, 58-71.

	With Rain-water.	With Sulphate of Potash.	With Phosphate of Potash.	With Phosphate of Potash and Nitrate of Lime.
No leather used: —				
In Berkshire sand,	.200	.200	.155	.665 *
In Provincetown sand,	.170	-	.165	3.050
In loam and sand,	.270	-	.160	5.830
Raw sheepskin (20): —				
In Berkshire sand (1,300),	.100	.130	.055	.640 *
In Provincetown sand (1,450),	.080	-	.100	1.400
In loam and sand (1,320),	.170	-	.120	4.020
Raw sole-leather (40): —				
In Berkshire sand (1,300),	.110	.115	.120	.280
In Provincetown sand (1,450),	.120	-	.110	2.820
In loam and sand (1,320),	.130	-	.150	3.720
Roasted sheepskin (20): —				
In Berkshire sand (1,300),	.105	.190	.060	.250
In Provincetown sand (1,450),	.250 *	-	.470 *	.345 *
In loam and sand (1,320),	.850	-	.700	3.060
Roasted sole-leather (40): —				
In Berkshire sand (1,300),	.220 *	.230	.210 *	.360 *
In Provincetown sand (1,450),	.910	-	1.750	3.120
In loam and sand (1,320),	2.120	-	1.980	4.785

* Immature when harvested.

Storer says: "It will be seen plainly enough that, while neither the sheepskin nor the sole-leather supplied any nitrogenous food to the buckwheat plants, some nitrogen was unquestionably obtained by the plants from the roasted leathers, a little from the roasted sheepskin and a decidedly larger amount from the roasted sole-leather. . . . In all cases the light, bulky material tended to interfere with the growth of the plants. The roasted-leather jars exhibited a marked growth of fungus, the raw-leather jars showed none, corroborating the evidence as to the existence of available products in the roasted leather. There is but little in the results above given to encourage the belief that roasted leather can have any definite money value as a manure."

Wagner * has made an exhaustive study of the value of different forms of nitrogen, having conducted 366 plat and pot experiments. The experiments were carried on for several successive years in a soil rich enough in lime to favor nitrification, and every effort was made to have the conditions equal in all cases. But a very brief résumé can be given at this time. One experiment was conducted for three successive years upon small plats of soil. Summer rye was planted the first year, summer wheat the second and carrots the third year. Placing the value of the returns from the nitrate of soda plats at 100, the other forms of nitrogen had the following relative worth: —

	First Year.	Average First and Second Years.	Average Three Years.
Nitrate of soda,	100	100	100
Blood,	67	67	69
Fish,	51	59	64
Steamed bone meal,	42	53	61
Leather,	13	12	20

Experiments were also conducted in pots with various soils, but the results cannot be noticed here.

In concluding his remarks relative to this subject Wagner says: —

> When I take all things into consideration, . . . I think I may present the following figures as an expression of the relative value of nitrogen in different forms of nitrogen-containing material: —

Nitrate of soda,	100
Sulphate of ammonia,	90
Blood, horn meal and green crops,	70
Fine-ground bone, fish and tankage,	60
Stable manure,	45
Wool dust,	30
Leather,	20

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* Die Stickstoff-düngung, etc., page 255.

So far as the writer has been able to ascertain, Wagner does not state the form of the leather used.

Taking the price of nitrogen in nitrate of soda at 14.8 cents, a pound of nitrogen in stable manure would be worth 6.7 cents and in leather 2.8 cents.

B. ARTIFICIAL DIGESTION EXPERIMENTS WITH LEATHER.

Stutzer and Klinkenberg were the first to propose this method. They argued that the amount of nitrogenous material that could be dissolved or digested would give a fairly correct idea of the value of the substance as a source of nitrogen for growing plants. They prepared the digestive fluid by extracting the inner lining of a pig's stomach, cut fine, with five litres of 0.2 per cent. hydrochloric acid for two days, filtering the solution, and preserving in glass-stoppered bottles, adding a few grams of salicylic acid to prevent fermentation. They submitted a variety of materials to the action of this solution. A few results are given below: —

SUBSTANCE.	Per Cent. of Nitrogen digested.
Blood,	89.75
Leather (cooked, and then roasted),	39.19
Raw bone,	98.70
Steamed bone,	90.50

Drs. Shepard and Chazal * afterwards submitted a great variety of nitrogen-containing materials to the action of Stutzer's solution. Several of the results obtained are presented below: —

	Per Cent. of Nitrogen digested.
Roasted leather meal,†	37.80
Dried blood (black),	78.61
Fish scrap,	88.67

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* See Report of Connecticut Experiment Station, 1885, page 117.

† The authors remark that "this prepared leather was an excellent article, so far as preparation goes, and one capable of being used in the fertilizer trade without much fear of detection."

Johnson, Farrington and Winton,* instead of using Stutzer's solution, dissolved 5 grams of Golden Scale Pepsin in 1,000 cubic centimeters of 0.2 per cent. hydrochloric acid, and digested a variety of substances in this fluid. Their investigation is the most valuable we possess in this direction. A few of their results may be cited: —

	Per Cent. of Nitrogen digested.
Dried blood (two samples),	97.30
Dry ground fish,	71.20
Leather No 3,†	23.40
Leather treated by benzine process,	35.90
Leather treated by superheated steam,	33.30
Mixed fertilizer A, containing 2.02 per cent. leather nitrogen,	23.40
Mixed fertilizer B, containing 2.00 per cent. leather nitrogen and 1.75 per cent. blood nitrogen,	55.60

In this connection it might be in place to mention the experiments recorded on the putrefaction of ammoniates, at first suggested by A. Morgen.‡ He put leather and horn meal in water to which a small amount of fecal extract had been added, and then allowed the solution to stand for thirty-one days at 30° C. The nitrogen made soluble was then estimated: —

In Experiment I., 10 grams material + 1,000 cubic centimeters water were used.

In Experiment II., 5 grams material + 1,000 cubic centimeters water + 5 cubic centimeters fecal extract.

In Experiment III. the same, with 10 grams material + 5 cubic centimeters fecal extract.

	Per Cent. of Soluble Nitrogen.
Leather meal, average of three experiments,	34.56
Horn meal, average of three experiments,	61.62

Johnson * repeated Morgen's work on a very large number of substances; a few of the results are given below. He allowed his solution to stand two weeks: —

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* *Loc. cit.*

† Fine and brittle, but method of preparation not known.

‡ Landw. Vers. Stat., 1880, **50**; Biedermann's Centralblatt, **9**, 801.

	Per Cent. Nitrogen Soluble.
Blood,	76.80
Fish,	78.10
Fish,	54.60
Bone,	79.00
Leather No. 3,	12.20
Steamed leather,	42.30
"Prepared ammoniate" (probably leather),	35.70

Johnson remarks that "this test of putrefaction draws the same line between those classes of ammoniates that was drawn by the pepsin digestion."

C. NITRIFICATION EXPERIMENTS WITH LEATHER.

These experiments were carried out by Müntz and Girard * with quite a number of nitrogen-containing substances. They were conducted in the laboratory, and care was taken to see that the soil was properly aired, and that moisture, temperature, etc., were favorable to the experiment. Ordinary soil was at first used, the amount of nitrates present being carefully noted, and a small amount of the substances to be nitrified then added. After a certain time the nitrates were washed out with water and estimated. A very short résumé is here presented: —

Nitrogen Nitrified, per 100 Parts of Nitrogen added to the Soil.

	I. Thirty Days.	II. Thirty-nine Days.	III. Thirty-two Days.
Sulphate of ammonia,	75.00	83.76	83.76
Dried blood,	72.44	73.56	84.50
Roasted horn,	71.03	73.17	46.82
Roasted leather,	11.62	16.47	13.26

In order to study the influence of different kinds of soil upon the process of nitrification, the experiment was repeated with soils from various sections of the country: —

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* Ann. Agron., 17, 290; Agric. Science, 7, 408–412. Deherain, *Chimie Agricole*, page 621.

Nitric Nitrogen found in Different Soils within a Certain Time.

	Light Soil of Joinville (Grams).	Chalky Soil (Grams).	Garden Earth (Grams).	Very Heavy Limey Clay (Grams).	Marsh Soil, Sour, Bretagne (Grams).
Sulphate of ammonia,	2.69	1.78	–	.510	None.
Blood, . . .	1.62	.73	–	.036	"
Roasted horn, . .	1.22	–	1.08	.029	"
Roasted leather, .	.41	.24	.55	.036	"

These experiments in general coincide with field and pot experiments as well as with artificial digestion experiments. It is worthy of note that the light sandy soil was most favorable to the process of nitrification, while the very heavy clay, and especially the sour marshy soil, was decidedly unfavorable to the action of nitrifying organisms.

II. Investigations concerning the Value of Leather Refuse made at this Station.

1. Can Leather be identified in Fertilizer Mixtures?

If one were to depend upon the microscope, it would certainly be an impossibility to recognize leather in finely ground fertilizer mixtures. Even if material of a fibrous structure were detected it would be nothing strange, for all flesh presents such a structure. After leather has been submitted to heat or pressure all structure is destroyed. Able microscopists, who have attempted to identify the leather under the microscope, report it an impossibility.

With chemical reagents one is more successful. At least, tannic or gallic acids, from their well-known reaction with an iron salt, are easily recognized; and, while one perhaps could not positively declare that the tannic or gallic acids present were derived from leather, it certainly would be highly probable.

Dr. C. W. Dabney,* when director of the North Carolina

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* North Carolina Experiment Station Bulletin, No. 3, 1883: Horn, Leather and Wool Waste.

Experiment Station, published a bulletin in which he suggests that the best reagent for recognizing the tannic acid is a phosphoric acid solution of phosphate of iron. He states that, if leather be present in the substance examined, a purple color will soon appear if a few drops of this solution be added to the alkaline solution of the leather extract. The phosphoric acid solution of phosphate of iron was prepared as follows: ten grams of ferric chloride were dissolved in water, and sodium phosphate added till all the iron was precipitated as phosphate of iron. The phosphate of iron must be freshly prepared, otherwise it will dissolve slowly, if at all. The phosphate of iron was filtered and washed quite thoroughly with water, and both filter and precipitate brought into a beaker containing 400 cubic centimeters of water, to which had been added 40 grams of glacial phosphoric acid. A gentle heat dissolves the iron phosphate quite readily.

If a drop of pyrogallic acid is added to water, the solution made slightly alkaline with ammonia and then a cubic centimeter of the iron phosphate solution added, a dark purple color appears. If tannic acid is substituted for the pyrogallic acid, a dark wine color results. In order to recognize leather in a mixture, a small amount (one gram) of the substance supposed to contain it is placed in a beaker with 30–40 cubic centimeters of water, a few drops of sulphuric acid added, the liquid brought to boiling, filtered, a little of the iron phosphate solution added, and the solution then made slightly alkaline with ammonia. If leather is present, a dark purple to wine color will soon appear.

Should leather be present in a mixed fertilizer containing soluble phosphate of lime, the latter will of course be precipitated on the addition of ammonia, but this in no way interferes with the color reaction. The writer examined during the summer of 1893 quite a number of fertilizers officially collected in Massachusetts, but in no case was leather to be detected. When, however, ten per cent. of leather was added to a mixed fertilizer, and then tested with the phosphate of iron solution, the dark color, due to the presence of tannic or gallic acids, very distinctly appeared.

During the early summer of 1893 several samples of leather were received at the station. It was stated that large quantities of the material were on the market, and one could surmise, at least, that it might be used as a source of nitrogen in the manufacture of commercial fertilizers, organic nitrogen at the time being quite high in price. It was thought wise to submit the samples to several tests, and, for the sake of comparison, pure sole-leather, obtained by the writer at the cobbler's, and dried blood were also included.

Description of the Samples.

I. Sole-leather. — This leather was ground fine for future tests. Under the microscope it showed a distinct fibrous structure. It contained 2.76 per cent. of fat and 7.94 per cent. of nitrogen.

II. Steamed Leather. — Some of the finely ground leather was placed in pressure bottles, water added, and heated for six hours at 110 ° C. The leather was virtually subjected to three atmospheres of steam pressure. After treatment it had become very dark in color, and appeared as a jelly-like, amorphous mass. The microscope showed it to be devoid of any fibrous structure. The tannic or gallic acids were still easily recognized, showing that they had not been destroyed by the heat and pressure. When dry it became quite brittle, crumbling easily.

III. Coarse Leather sent to the Station. — This leather came in pieces, from the size of a walnut to that of a small hen's egg. It contained 37.47 per cent. of fat and 4.52 per cent. of nitrogen. The large amount of fat completely concealed its structure.

IV. Philadelphia Tankage. — The sample was very finely ground and quite dry. It contained 1.95 per cent. of fat, 7.80 per cent. of nitrogen and traces only of phosphoric acid. Its smell and general appearance indicated clearly that it was leather that had been roasted or steamed. To the eye it appeared to be lacking in fibrous structure, and with the microscope it appeared simply as a gelatinous mass.

V. Dried Blood. — It was an excellent sample, containing 12.71 per cent. of nitrogen and .64 per cent. of fat.

2. *Artificial Digestion of Different Leathers.*

The artificial digestion of the substances above described was carried out according to Stutzer's method. In the first series of trials both the pepsin and pancreas solutions were used. The preparation of the pepsin solution has already been described.

The pancreas solution was prepared by taking the fresh pancreas of an ox, cutting it fine, mixing it with sand and allowing it to stand twenty-four to thirty-six hours exposed to the air. It was then rubbed with lime water and glycerine (to every 1,000 grams of the pancreas-sand mixture use 3 litres of lime water and 1 litre of glycerine of 1.23 specific gravity), and the resulting fluid allowed to stand with occasional stirring for five days. It was then filtered through cloth to remove the coarse portions, heated to 40° C. for two hours, and finally filtered through folded filters and preserved in bottles. To prepare the pancreas solution used in the process of digestion, 250 cubic centimeters of the above-described solution were mixed with 750 cubic centimeters of soda solution. The soda solution contained 5 grams of carbonate of soda dissolved in 750 cubic centimeters of water. The pancreas solution thus prepared was heated for one to two hours at 37°–40° C., filtered to remove any flocky precipitate, and 100 cubic centimeters used for each test.

The results of the pepsin-pancreas digestion were as follows: —

		Per Cent. of Nitrogen digested.
I.	Sole-leather finely ground,	80.98
II.	Same leather after being heated six hours at 110° C. in pressure bottles with water,	97.23
III.	Coarse leather (free from fat),	52.00
IV.	Philadelphia tankage,	90.64
V.	Dried blood,	99.13

The above results are all very high, but this is not surprising, for the action of dilute alkalies on leather is well known and has been several times referred to. In the present case, after the various leathers had been submitted to the pepsin digestion there appeared to be no very great change either in their appearance or bulk. Blood, on the other hand, was nearly all dissolved by the pepsin solution. As soon, however, as the leathers were submitted to the action of the pancreas solution a decided change was noted; the solution became quite dark in color and the larger part of the leather went into solution. While this method indicated a greater availability on the part of the sole-leather *after it had been submitted to steam pressure*, it nevertheless did not give a correct idea of the digestibility and consequent availability of the leather when compared with the dried blood.

The substances were therefore submitted to the action of the pepsin solution alone, with results as follows: —

		Percentage Digestibility of Nitrogen.
I.	Sole-leather,	13.70
II.	Sole-leather after steam pressure,	34.40
III.	Coarse leather,	–
IV.	Philadelphia tankage,	42.30
V.	Dried blood,	97.80

These results coincide very closely with those obtained by other investigators. The sole-leather itself proved very indigestible. It is possible that it might have proved somewhat less so if no hydrochloric acid had been added during the digestion.* The sole-leather *after* being subjected to the action of the steam pressure had a digestibility of 34.40 per cent., which coincides with results obtained by others for prepared leather, as the following samples show: —

	Percentage of Nitrogen digested.
Leather cooked and roasted (Stutzer),	39.19
Roasted leather meal (Shepard and Chazal),	37.80
Leather by benzine process (Johnson),	35.90
Leather by superheated steam (Johnson),	33.30

While, then, the action of steam and heat renders the leather somewhat more digestible and probably more available in the soil, it still has a digestibility below 50 per cent. Only the very poorest kinds of animal matter reach this low figure (50). The so-called Philadelphia tankage was also below 50 per cent. digestible, and may be classified with the steamed or roasted leathers as regards its value. It is to be noted, as before mentioned, that the dried blood was nearly all digested by the action of the pepsin solution, and may be regarded as a very excellent standard with which to compare the various leathers.

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* Connecticut Experiment Station, 1886, page 122.

General Conclusions relative to Raw, Roasted or Steamed Leather.

The results of the combined experiments in the field and in pots, together with artificial digestion experiments, and nitrification experiments, indicate that leather, either raw, roasted or steamed, is a very slow-acting form of nitrogen as a source of plant food. It certainly would be fraudulent to sell it in mixed fertilizers as a source of organic nitrogen, and the Massachusetts fertilizer law distinctly forbids it to be thus utilized. Carefully conducted experiments by Wagner give it a relative value of twenty, nitrate of soda being equal to one hundred. From the mass of evidence at our command it would seem that this figure about expresses its relative worth as a direct source of plant food. If it is offered for sale as a fertilizer, it should be sold as leather. When nitrogen in organic matter has a value of sixteen to eighteen cents per pound, nitrogen in raw, steamed or roasted leather should be worth but three to six cents per pound.

3. *Action of Sulphuric Acid on Leather.*

Deherain and others suggest that if leather be dissolved in sulphuric acid its nitrogen will be made as valuable as that in any form of animal matter. No experiments, however, are brought forward to prove such a statement, but it is generally understood that many European manufacturers thus turn leather waste to account. In order to study this question more closely a number of experiments were carried out by the writer, a few of which are presented below: —

Experiment I. — Sixty-five grams of 50° B. sulphuric acid were heated in a porcelain dish over a water bath of about 90° C., and 12 grams of leather gradually added. A dark, thick fluid resulted. Thirty cubic centimeters of water were then added to dilute the thick fluid somewhat, and bone ash was employed to dry off the resulting semi-fluid mass.

One hundred and thirty-six grams of superphosphate were obtained, which gave no tannic acid reaction.

Experiment II. — To 30 grams of 50° B. sulphuric acid, heated as above described, were added 12 grams of leather. A dark, thick paste was obtained, to which were added 25 cubic centimeters of water and 33 grams of bone ash. Seventy-three grams of superphosphate were obtained. The reaction of tannic acid was not strong.

Analyses of the two products were made as follows: —

	I. Per Cent.	II. Per Cent.
Moisture,	18.03	15.59
Soluble phosphoric acid,	14.84	11.80
Reverted phosphoric acid,	.69	1.50
Insoluble phosphoric acid,	1.43	3.38
Total phosphoric acid,	16.96	16.68
Nitrogen,	.70	1.20

Experiments III., IV., V., VI. — The previously described Philadelphia tankage was used in these experiments, and South Carolina floats in place of bone ash. The objects in view were to see (*a*) how much leather could be used without giving a tannic acid reaction, (*b*) to note, if possible, to what extent the leather interfered with the action of the sulphuric acid upon the floats, (*c*) to notice the approximate percentage of available phosphoric acid and nitrogen resulting, (*d*) to see if any nitrogen in the resulting superphosphates was soluble in water, (*e*) to note the amount of nitrogen in the superphosphate artificially digestible by Stutzer's solution. To make this latter estimation (*e*), 5 grams of superphosphate were stirred with water, filtered, and washed till the wash water was no longer acid. The portion not soluble in water was treated with pepsin solution.

Experiment III. — To 30 grams of 50° B. sulphuric acid, after heating, previously described, were added 12 grams of Philadelphia tankage. A thick, black dough resulted. It was diluted with 25 cubic centimeters of water, appearing then as a thick, black fluid. To this fluid were added 60 grams of floats. The resulting superphosphate, after drying in the air for twenty-four hours, weighed 102 grams. The tannic acid reaction was quite strong.

Experiment IV. — To 30 grams of 50° B. acid were added 25 cubic centimeters of water and 70 grams of floats. The dry superphosphate weighed 101.5 grams.

Experiment V. — To 30 grams of 50° B. acid were added 9 grams of Philadelphia tankage, which resulted in a medium thick paste. Twenty cubic centimeters of water and 48.5 grams of floats were afterwards added. The dry superphosphate weighed 88 grams, and gave *no* tannic acid reaction.

Experiment VI. — To 30 grams of 40° B. acid 9 grams of Philadelphia tankage were added, resulting in a medium thick paste. This paste was diluted with 20 cubic centimeters of water, and 50 grams of floats were put in. Seventy-nine grams of superphosphate were obtained, which gave a strong tannic acid reaction.

These several products were analyzed: —

	III. Per Cent.	IV. Per Cent.	V. Per Cent.	VI. Per Cent.
Moisture,	14.14	14.13	14.86	-
Soluble phosphoric acid,	6.78	7.30	7.80	-
Reverted phosphoric acid,	1.22	1.60	.44	-
Insoluble phosphoric acid,	5.50	6.66	4.94	-
Total phosphoric acid,	13.50	15.56	13.18	-
Total nitrogen,	.81	-	.87	1.03
Nitrogen after artificial digestion,	.37	-	.25	.41
Per cent. of total nitrogen digested,	54.00	-	71.00	60.00
Soluble nitrogen,	trace	-	trace	-

It would appear that 9 grams of leather were all that could be added to 30 grams of sulphuric acid without getting the tannic-acid reaction. When, as in Experiment III., 12 grams of leather were added, the reaction for tannic acid was quite marked, and the nitrogen in the superphosphate had a digestibility of but 54 per cent. Experiment VI. indicates that 40° B. sulphuric acid was not quite strong enough to thoroughly disintegrate the 9 grams of leather, for the tannic acid in the superphosphate was easily recognized, and the nitrogen was but 60 per cent. digestible. When 9 grams of the Philadelphia tankage were dissolved in 30 grams of 50° B. acid, no tannic acid could be recognized, and 70 per cent. of the total nitrogen was digestible. This is probably the average percentage of organic nitrogen that would be found digestible in mixed fertilizer, as offered for sale in our markets. Such a result is quite encouraging. It would seem from the analysis of IV. that the leather had not seriously interfered with the action of the sulphuric acid upon the floats. We have in the four experiments above cited added rather too much phosphate rock and water, and in the two following experiments less were added.

Experiment VII.—To 30 grams of 50° B. acid 9 grams of Philadelphia tankage were added, and then 12 cubic centimeters of water. To the thick fluid resulting 41 grams of floats were added. After standing twenty-four hours the material could be easily handled, and weighed 71.5 grams.

Experiment VIII.—To 30 grams of 50° B. acid 9 grams of Philadelphia tankage were added, producing a thick, pasty mass. Without the addition of water 28 grams of floats were stirred in, and after twenty-four hours the mass weighed 63 grams. The phosphate was quite black in color and sticky. It needed at least 5 to 7 grams more floats before it could be easily handled. It was plain that the sulphuric acid was not all neutralized. If no water were added to dilute the thick, pasty mass, it would be very difficult to work in the floats should large quantities be mixed.

Analyses.

	VII. Per Cent.	VIII. Per Cent.
Moisture,	17.95	16.95
Soluble phosphoric acid,	6.79	5.99
Reverted phosphoric acid,	2.16	1.62
Insoluble phosphoric acid,	1.94	1.56
Total phosphoric acid,	10.89	9.17
Total nitrogen,	.90	1.06

In Experiment VII. 8.95 per cent. of available phosphoric acid was obtained, with but 1.94 per cent. of insoluble acid and .90 per cent. of nitrogen; the phosphate was also in good mechanical condition and gave no tannic-acid reaction. The proportions of water, sulphuric acid, floats and leather appear to be about correct, and the percentages of available phosphoric acid and nitrogen as high as could be expected, with floats as a dryer.

Experiment IX.—In experiments III. to VIII. Philadelphia tankage was used as a source of leather.

In this experiment pure fine-ground sole-leather was used, to see if the sulphuric acid acted as strongly upon the pure leather as upon the prepared article. To 30 grams of 50° B. acid were added 9 grams of sole-leather, 20 cubic centimeters of water and 60 grams of floats.

The resulting phosphate weighed 98.5 grams.

Analysis gave the following results:—

	Per Cent.
Total nitrogen in the superphosphate,	.710
Total nitrogen after digestion,	.220
Total nitrogen digested,	69.000
Nitrogen soluble in water	.047
Per cent. of soluble nitrogen,	6.620

No tannic acid could be detected in this superphosphate. The artificial digestion of the nitrogen was made by taking 5 grams of the substance, washing out the soluble phosphoric acid with water, and proceeding in the usual manner.

It is to be noted from the above figures that the nitrogen in the sole-leather thus treated was as digestible as is the average animal matter sold for fertilizing purposes.

Practical Deductions.

The various experiments made would indicate that leather, sulphuric acid, water and floats should be mixed in about the following relative proportions:—

	Pounds.
Sulphuric acid, 50° B.,	2,000
Ground leather,	600
Water,	800
Floats,	2,700

The resulting mixture, when in fairly dry condition, would weigh approximately 5,000 pounds, shrinking about 18 to 20 per cent. It would have approximately the following composition: —

	Per Cent.
Moisture,	18.00
Available phosphoric acid,	8.50
Insoluble phosphoric acid,	2.00
Total phosphoric acid,	10.50
Total nitrogen,	.90

Two thousand pounds of sulphuric acid will not take up more than 600 pounds of leather and render the leather 70 per cent. digestible. If more is added, part of the latter, whether roasted or raw, will not be thoroughly acted upon by the acid. With 600 pounds of leather a thick paste results, which must be diluted somewhat with water in order to allow the sulphuric acid to act freely upon the floats. If bone ash should be used as a dryer, in place of ground phosphate rock, a higher percentage of available phosphoric acid and of nitrogen would result, as experiments I. and II. indicate.

Before submitting the leather to the action of the sulphuric acid, it would undoubtedly be better, after extracting the fat, to steam or roast it, in order that it may be easily pulverized. Raw, untreated leather is ground only with difficulty, and if the mechanical condition of the leather were poor, the action of the sulphuric acid would be imperfect.

POT EXPERIMENTS WITH DISSOLVED LEATHER.

BY J. B. LINDSEY AND R. H. SMITH.

In order to still further study the availability of the nitrogen in dissolved leather, pot experiments were instituted, and the result of our first year's trial is here presented.

The Pots used.

The pots were made of thin galvanized iron, and were seven and three-quarters inches in diameter and eight inches deep. A galvanized-iron tube, half an inch in diameter, extended from the top to the bottom of the pot, connecting at the base with a second tube of the same material, one inch in diameter. This latter tube extended along the bottom of the pot and was perforated with small holes. The object of these tubes was to supply water partially from the bottom.

The Soil.

In order to test the availability of different sources of nitrogen, the soil to be used for such a purpose should be as poor in this ingredient as possible. If not naturally in such a condition, it should be rendered so by previous cropping. As we had not an ideal soil at hand for such a purpose, a sandy subsoil was selected that was poor in all of the several ingredients of fertility. It had the following composition: —

	Per Cent.
Moisture when tested,	14.25
Phosphoric acid,	.13
Potassium oxide,	.08
Nitrogen,	.09

The Fertilizers used.

In order to turn the nitrogen to the very best account, phosphoric acid and potash must be supplied in excess.

The sources of nitrogen were nitrate of soda, dissolved leather and Philadelphia tankage. The Philadelphia tankage has already been described. The dissolved leather was prepared as follows: to 210 grams of c. p. sulphuric acid of 50° B., heated to 80° C., were added 63 grams of finely ground sole-leather. The mixture was thoroughly stirred, and allowed to stand for half an hour; a dark pasty mass resulted. Forty-nine grams of water were added to thin the paste somewhat, and then finely ground calcium carbonate (marble) was added, to take up the excess of sulphuric acid, and enable us to secure a dry, easily handled material. We used the carbonate instead of the phosphate of lime as a dryer, in order to avoid an excess of phosphoric acid. After standing twenty-four hours the substance had dried out sufficiently to be easily handled and ground.

Double superphosphate was used as a source of phosphoric acid, and the potash was applied in the form of the double sulphate of potash and magnesia.

Composition of the Fertilizers.

	Dissolved Leather.	Philadelphia Tankage.	Nitrate Soda.	Double Superphosphate.	Sulphate of Potash and Magnesia.
Moisture, ...	-*	-*	2.09	5.74	8.10
Nitrogen, ...	.97	7.80	14.28	-	-
Soluble phosphoric acid, . .	-	-	-	38.38	-
Reverted phosphoric acid, . .	-	-	-	9.04	-
Available phosphoric acid, . .	-	-	-	47.42	-
Insoluble phosphoric acid, . .	-	-	-	.38	-
Total phosphoric acid, . . .	-	-	-	47.80	-
Potassium oxide, ...	-	-	-	-	24.32

* Not determined.

Arrangement of the Experiment.

Eighteen pots were used in the experiment, fertilized as follows: —

Pots.	Source of Nitrogen.	Amount of Nitrogen applied (Grams).	Amount of Available Phosphoric Acid applied (Grams).	Amount of Potassium Oxide applied (Grams).
Pots 1, 2, 3, . .	Soil nitrogen, . .	-	1.20	2.40
Pots 4, 5, 6, . .	Philadelphia tankage, .	.60	1.20	2.40
Pots 7, 8, 9, . .	Nitrate soda, . . .	.30	1.20	2.40
Pots 10, 11, 12, . .	Nitrate soda, . . .	.60	1.20	2.40
Pots 13, 14, 15, . .	Dissolved leather, . .	.30	1.20	2.40
Pots 16, 17, 18, . .	Dissolved leather, . .	.60	1.20	2.40

Pots 1, 4, 7, 10, 13, 16 were infected with a small quantity of cultivated soil, in order to note if the infection facilitated the nitrification of the organic nitrogen in case of our experiments. To each of these pots were also added 10 grams of air-slacked lime.

Filling the Pots.

About an inch of good clean gravel was first added to the pots, and then five centimeters of the well-mixed soil (three and one-half pounds). The fertilizer (one-half of the nitrate of soda only at this time) was then thoroughly mixed with six and one-half pounds of the soil and added; this addition increased the depth nine centimeters. Two pounds of the mixed soil (three centimeters) were next put in, and finally the oats (one gram of seed per pot) were scattered in and covered with one-half pound of the soil. Twelve and one-half pounds of soil were therefore added to each pot, and filled it to within one centimeter of the top. After each addition of soil the pot was somewhat shaken, but the soil was not at all pressed in. The filling and planting were completed on April 25.

General Care of the Experiment.

The pots were set into a wagon running on an iron track. The floor of the wagon was surrounded with sides six inches deep. The space between the pots was filled with sawdust, which was kept moist, in order to keep the soil in the pots as cool as possible during the hot summer weather. The pots were carefully watched and kept sufficiently watered. A portion of this water was supplied from beneath, and the remainder was added to the surface with a sprinkling pot. Sometimes it became necessary to water twice daily. The pots were kept in the open whenever the weather permitted. During wet or windy weather, and at night, they were run under cover.

Notes.

The oats appeared April 30. When they were about two inches high, twelve plants were removed from each pot, as they appeared rather thick.

Appearance June 1.

Pots 1, 2, 3. Oats were eleven to thirteen inches high. They began to appear light green, up to yellow, and spindly.

Pots 4, 5, 6. Oats were but very little better in appearance than those in pots 1, 2 and 3.

Pots 7, 8, 9. Plants were dark green, stocky, and eleven to thirteen inches high.

Pots 10, 11, 12. Plants appeared dark green, very stocky, and were eleven to fifteen inches high.

Pots 13, 14, 15. Leaves broad, very dark green, and plants twelve to fifteen inches high.

Pots 16, 17, 18. Same as pots 13, 14, 15.

On June 4 pots 7, 8, 9 began to show nitrogen hunger, by appearing a lighter green; the ends of the leaves were turning yellow. The other half of the nitrate of soda was therefore added in 350 cubic centimeters of water to pots 7, 8, 9, 10, 11 and 12. From this time on (June 4) the plants in pots 1, 2, 3, 4, 5 and 6 grew quite slowly, had a light-green and spindly appearance. On June 22 the oats in all the pots (excepting 10, 11, 12) began to head. The latter showed the heads about a week later.

The plants retained their same relative appearance till harvested.

The plants in pots 10, 11, 12 were a deep rich green and stocky, but failed to mature much grain, as our tabulated results will show.

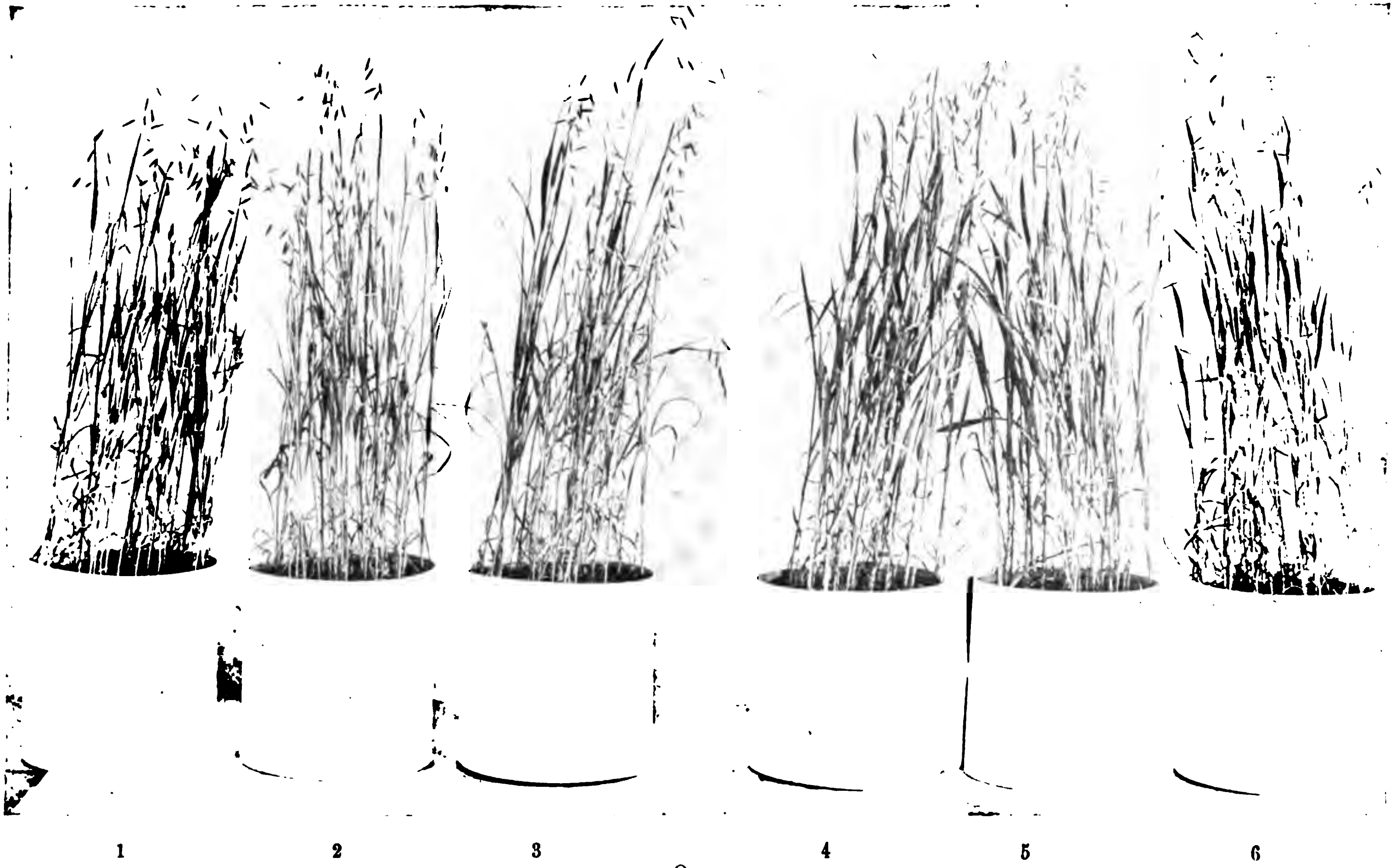
Harvesting.

The plants were harvested as they matured. The oats in pots 1, 2, 3 were cut, for example, July 23, while those in pots 10, 11, 12 not till August 10. They were cut close to the soil, put in large paper bags, and hung away to dry.

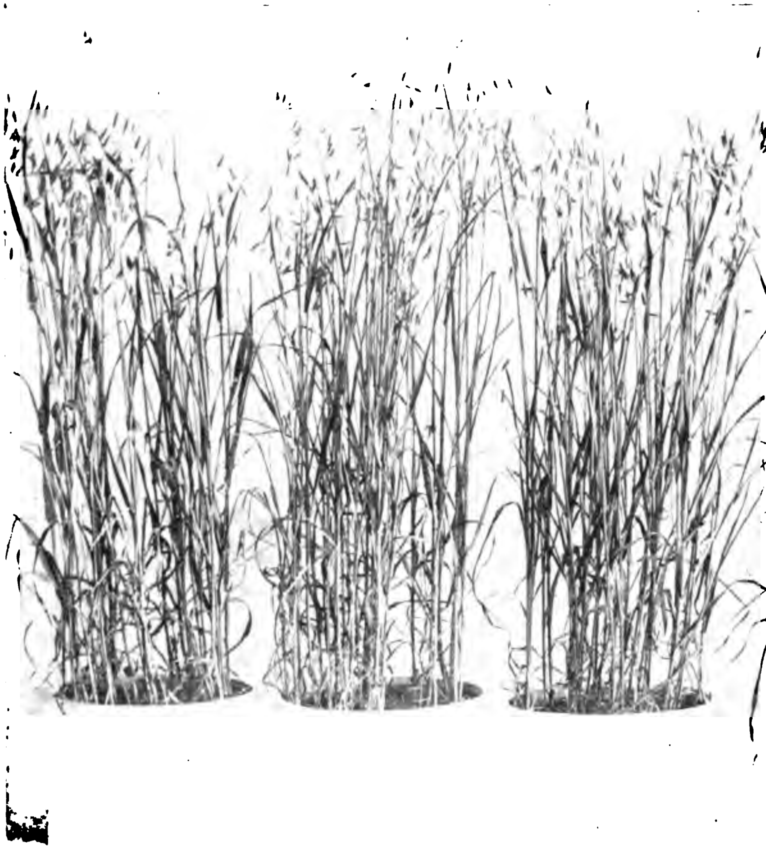
The photographs that follow show the relative appearance of the plants in pots 1, 2, 3, 4, 5, 6, 7, 8, 9, 13, 14, 15, a short time before harvesting. The photographs of the plants in pots 10, 11, 12, 16, 17, 18 are not presented, for reasons that will be stated further on.

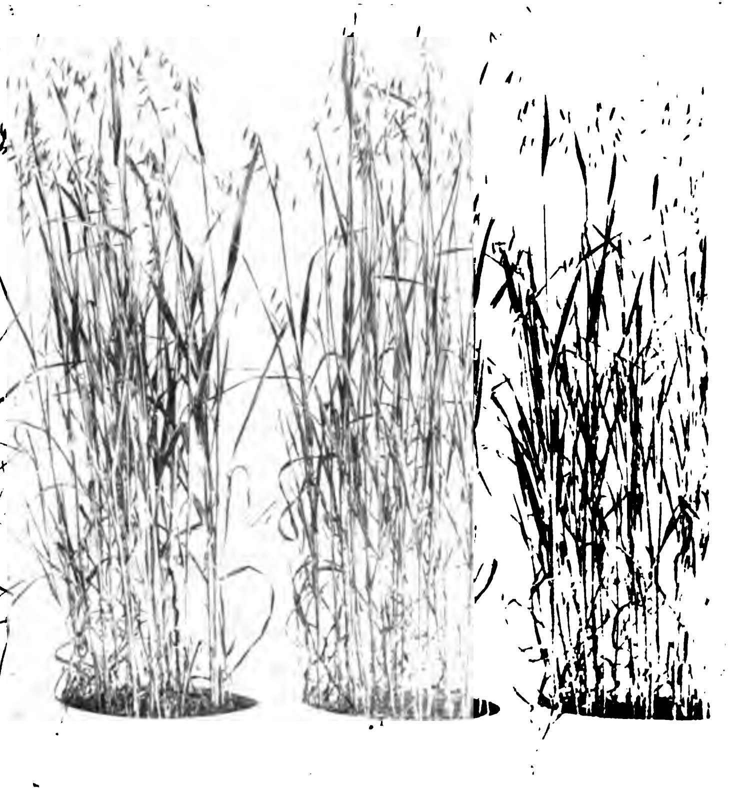
Comments.

Pots 1, 2, 3, 4, 5, 6 (see first photograph) have the same general appearance, though the latter contain a trifle more foliage. Pots 7, 8, 9, fertilized with .30 grams of nitrogen from nitrate of soda, and pots 13, 14, 15, with the same amount of nitrogen in the form of dissolved leather (see second photograph), compare to the eye very favorably one with the other. The plants in the nitrate pots are not quite as tall, but more stocky.



Oats.





OATS.

0.300 g. nitrogen from nitrate soda + phosphoric acid + potash

0.300 g. nitrogen from dissolved leather + phosphoric acid + potash

The Results.

After the product from each pot was thoroughly air dry, the grain was carefully removed, weighed, coarsely ground, and dry-matter determinations made. The straw was cut into short lengths, and together with the chaff tested for dry matter. Finally, both grain and straw were ground fine, and nitrogen determinations made.

Table I.

FORM OF NITROGEN.	Quantity of Nitrogen added to Each Pot (Grams).	DRY MATTER YIELDED BY SINGLE POTS.		AVERAGE DRY MATTER FROM THREE POTS.		GAIN IN DRY MATTER OVER SOIL NITROGEN POTS, ON BASIS OF .30 GRAM OF NITROGEN APPLIED.		IF GAIN IN DRY MATTER WITH NITRATE SODA EQUAL 100, THEN OTHER SOURCES OF NITROGEN WOULD BE EQUAL TO —		Average of Straw and Grain.
		Straw (Grams).	Grain (Grams).	Straw (Grams).	Grain (Grams).	Straw (Grams).	Grain (Grams).	Straw.	Grain.	
Soil nitrogen, ...	.00 .00 .00	7.777 7.683 8.013	1.893 1.598 1.569	7.82	1.69	-	-	.00	.00	-
Philadelphia tankage, ...	.60 .60 .60	9.524 8.447 8.684	1.171 .899 2.906	8.88	1.66	.53	±	5.40	±	2.70
Nitrate of soda, ...	.30 .30 .30	16.624 18.126 18.021	6.155 6.969 5.986	17.59	6.37	9.77	4.68	100	100	100
Dissolved leather, ...	.30 .30 .30	15.245 14.454 13.362	4.348 4.663 3.728	14.35	4.25	6.53	2.56	66.8	54.7	60.7
Nitrate of soda, ...	.60 .60 .60	19.521 20.275 18.813	2.197 1.682 1.679	19.54	1.85	-	-	-	-	-
Dissolved leather, ...	.60 .60 .60	19.933 18.723 20.623	4.350 5.223 5.197	19.76	4.92	-	-	-	-	-

Comments on Table I.

The first four columns in the table show the weight of straw and grain (dry matter) produced by each pot, and the average from each three pots. The next three columns indicate the gain in dry matter over those pots containing only soil nitrogen. Then follow the comparative yields, nitrate of soda being rated at 100. When the average of both straw and grain is considered, it will be seen that the dissolved leather yielded 60.7 per cent. as much as the same quantity of nitrogen in the form of nitrate of soda. The Philadelphia tankage, on the other hand, gave but a slight increase over the no-nitrogen pots; this slight gain was in the yield of straw.

In case of the last six pots, where .60 gram of nitrogen was applied in the forms of nitrate of soda and dissolved leather, we find a large amount of straw produced, but very little grain. This, in all probability, can be attributed to two causes: in the first place, in case of the nitrate of soda, one-half the quantity was not applied till early June, and this application might have been too late to enable the plants to take it up and work it over into grain; in the second place, there might not have been phosphoric acid and potash enough present to have enabled the plants to turn the nitrogen to account. Twice as much phosphoric acid and four times as much potassium oxide as nitrogen were applied; the coming year these amounts will be doubled, in order to make sure that a sufficient quantity is present. The results from these latter pots, therefore, are simply stated, but not further considered.

Table II.

FORM OF NITROGEN.	Quantity Nitrogen to Each Pot (Grams).	Nitrogen in Total Dry Matter produced (Grams).	NITROGEN IN 100 GRAMS DRY MATTER (GRAMS).		For Every 100 Parts of Nitrogen applied, there has been returned in Straw and Grain —	When Nitrate Soda equals 100, Other Sources of Nitrogen equal to —	EVERY GRAM OF NITROGEN APPLIED HAS PRODUCED IN DRY MATTER —			For Every 100 Parts of Straw, there has been produced in Grain —
			Straw.	Grain.	(Parts.)		Straw (Grams).	Grain (Grams).	Straw and Grain (Grams).	
Soil nitrogen, ...	.00	.0945	.68	2.604	-	-	-	-	-	21.60
Nitrate of soda, ...	.30	.3050	.78	2.716	70	100	32.57	15.60	48.17	36.20
Dissolved leather, ...	.30	.2100	.68	2.660	39	56	21.77	8.53	30.30	29.60
Philadelphia tankage, ...	.60	.1260	.96	2.510	5.3	7.6	.88	-	.88	18.69
Nitrate of soda, ...	.60	.4250	-	-	55	-	-	-	-	-
Dissolved leather, ...	.60	.3250	-	-	39	56	-	-	-	-

Comments on Table II.

The first two columns show the sources of nitrogen and the quantity applied to each pot. The third column shows the total average nitrogen found in the dry matter produced by each pot. Where no nitrogen was applied, the soil yielded of itself .0945 gram, and the excess over this amount obtained in the other series represents the amount that the plants succeeded in getting from the nitrogen applied. The next column shows that for every 100 parts of nitrogen applied in the form of nitrate of soda 70 parts were obtained in the grain and straw; the other 30 parts would probably largely if not entirely be found in the roots. For every 100 parts of nitrogen applied in the form of dissolved leather 39 parts were returned, while for every 100 parts applied in the form of Philadelphia tankage but 5.3 parts were recovered. The next column shows that, if the amount of nitrogen returned in case of the nitrate of soda pots be represented by 100, then the amount returned in case of dissolved leather would be 56, and in case of Philadelphia tankage 7.6. The last column indicates the parts of grain produced for every 100 parts of straw. Notice that where no nitrogen was applied only 21.6 parts of grain were produced to 100 parts of straw; but when .30 gram of nitrogen in form of nitrate of soda was added, 36 parts of grain were obtained to 100 parts of straw.

Résumé. — Action of Sulphuric Acid on Leather.

Artificial digestion tests show that nitrogen in either raw, steamed or roasted leather, after being acted on by 50° B. sulphuric acid, has a digestibility of 70 per cent. This test would class it, as regards availability, with the average quality of animal matter sold for fertilizing purposes.

The result of our first year's test with pot experiments indicates that, when nitrate of soda as a source of nitrogen is rated at 100, the nitrogen in the form of dissolved leather would be rated at about 60. The return from the Philadelphia tankage was very slight. The experiment will be continued the coming year.

12. Report on General Farm Work (1894).

The lands assigned for the use of the Massachusetts State Agricultural Experiment Station cover an area of fifty acres. Ten acres are natural woodlands, and forty acres, including the space occupied by the buildings, are used for the raising of farm crops. At present from fifteen to sixteen acres are under cultivation, and from sixteen to seventeen acres are permanent grass lands. As every portion of the land is at present serving for some special experiment, the general management of the farm is to a controlling degree subjected to the requirements of the work called for in connection with the various questions under investigation. The adoption of a thorough mechanical preparation of the soil, supported by a careful, clean cultivation of the crops raised, has brought the lands into a fair condition for field experiments. Each field has had for years its own system of manuring, and becomes thereby from year to year more valuable for experimental purposes. Wherever circumstances have been favorable, forage crops have been chosen, for the purpose of studying the influence of various systems of fertilization and cultivation on their growth and special character. This practice has resulted already in the successful introduction of some valuable forage plants new to our locality, and has also materially assisted us in an economical support of quite extensive experiments in stock feeding. The beneficial effect of many of these crops on the physical and chemical condition of our cultivated lands is everywhere noticed, when compared with their previous general condition.

During the past season soja bean, vetch and oats, vetch and barley, and vetch, oats and horse bean have been raised. The vetch and oats was fed in part green and the remainder was converted into hay for dairy cows. The soja bean was used in a mixed silage with corn. The vetch and barley and vetch, oats and horse bean were used for hay.

Twenty-six tons of corn have been put into the silos, about three to four tons being in the form of mixed silage with soja bean. Of the remainder, part was fed green and the rest harvested at maturity.

During the past season the area of the orchard has been laid down in permanent grass land. From three to four feet space around each tree has been left open for cultivation.

The amount and character of farm and garden crops raised in 1894 may be seen from the following statement: —

	Tons.
Hay (first cut),	33
Rowen,	6½
Potatoes,	6½
Oats (756 pounds grain, 2,224 pounds straw),	1½
Vetch and oats (hay),	3¾
Vetch and oats (green),	3½
Vetch and barley (hay),	9/10
Vetch, oats and horse bean (hay),	½
Fodder corn (green),	29
Soja bean (green),	3⅛
Hungarian grass (green),	2⅕
Barley (657 pounds grain, 1,378 pounds straw),	1
Rye (2,576 pounds grain, 11,072 pounds straw),	6¾
Tomatoes,	2¼
Onions,	7/10
Carrots,	2¼
Globe mangolds,	1 9/10
Spinach,	½
Lettuce,	⅕
Miscellaneous,	3
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PART III.

SPECIAL WORK IN THE CHEMICAL LABORATORY.

C. A. Goessmann.

I. Communication on Commercial Fertilizers: —
  1. General Introduction.
  2. State Laws for the Regulation of Trade in Commercial Fertilizers.
  3. List of Licensed Manufacturers and Dealers from May 1, 1894, to May 1, 1895 (58).
  4. Analyses of Licensed Fertilizers (253) (compiled by H. D. Haskins).
  5. Analyses of Commercial Fertilizers and Manurial Substances sent on for Examination (145) (compiled by C. S. Crocker).
  6. Miscellaneous Analyses (4) (compiled by C. S. Crocker).
  7. Miscellaneous Fodder Analyses (69) (compiled by C. S. Crocker).

II. Analyses of Milk sent on for Examination (40) (compiled by C. S. Crocker).

III. Analyses of Water sent on for Examination (200) (compiled by R. H. Smith).

IV. Compilation of Analyses made at Amherst, Mass., of Agricultural Chemicals and Refuse Materials used for Fertilizing Purposes (compiled by C. S. Crocker).

V. Compilation of Analyses made at Amherst, Mass., of Fodder Articles, Fruits, Sugar-producing Plants, Dairy Products, etc. (compiled by C. S. Crocker).

VI. Table of the Digestibility of American Feeding Stuffs (compiled by J. B. Lindsey): —
  A. Experiments with Ruminants.
  B. Experiments with Swine.

I.

COMMUNICATION ON COMMERCIAL FERTILIZERS.

1. General introduction.
2. State laws for the regulation of trade in commercial fertilizers.
3. List of licensed manufacturers and dealers from May 1, 1894, to May 1, 1895.
4. Analyses of licensed fertilizers.
5. Analyses of commercial fertilizers and manurial substances sent on for examination.
6. Miscellaneous analyses.
7. Miscellaneous fodder analyses.

1. General Introduction.

Fifty-eight manufacturers and dealers have applied for and received licenses for the sale of their various brands of fertilizers in our State. Twenty-five of them are residents of other States.

Two hundred and seventy-four samples of licensed articles have been collected in all parts of the State by an authorized agent of the station.* Two hundred and fifty-three of them have been carefully analyzed at the chemical laboratory of the station, with the following results: four samples contained all three essential constituents above the highest guarantee; twenty-five contained two of the essential elements above the highest guarantee; seventy contained one essential element above the highest guarantee; thirty-four contained three essential elements above the lowest guarantee; seventy-four contained two essential elements above the lowest guarantee; eighty-seven contained one element above the lowest guarantee; one contained three essential elements below the lowest stated guarantee; seventeen contained two essential elements below the lowest stated guarantee; seventy-six contained one element below the lowest stated guarantee. The deficiency in one or two essential constituents was in the majority of instances compensated for by an excess in the others.

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* Mr. H. D. Haskins, a graduate of the Massachusetts Agricultural College, of the class of '90, and for four years past an assistant in the chemical laboratory of the Massachusetts State Experiment Station.

The variations in the market price of prominent fertilizer constituents have been, on the whole, during the past year within the usual limits. Potash in its different forms, as well as nitrogen, has advanced in price compared with last year's quotations, while phosphoric acid has remained about the same.

The duties assigned to the director of the station, to act as inspector of commercial fertilizers, render it necessary to *discriminate*, in official publications of the results of analyses of commercial fertilizers and of manurial substances in general made at the station, *between analyses of samples collected by a duly qualified delegate of the experiment station, in conformity with the rules prescribed by the new laws, and those analyses which are made of samples sent on for that purpose by outside parties.* In regard to the former alone can the director assume the responsibility of a carefully prepared sample, and of the identity of the article in question.

The official report of analyses of compound fertilizers and of all such materials as are to be used for manurial purposes, which are sold in this State under a certificate of compliance with the present laws for the regulation of the trade in these articles, has been restricted by our State laws to a statement of chemical composition and to such additional information as relates to the latter.

The practice of affixing to each analysis of this class of fertilizers an approximate commercial valuation per ton of their principal constituents has, therefore, been discontinued. This change, it is expected, will tend to direct the attention of the consumers of fertilizers more forcibly towards a *consideration of the particular composition of the different brands of fertilizers offered for their patronage, a circumstance not infrequently overlooked.*

The *approximate market value* of the different brands of fertilizers obtained by the current mode of valuation does not express *their respective agricultural value, i. e.*, their crop-producing value; for the higher or lower market price of different brands of fertilizers does not necessarily stand in a direct relation to their particular fitness, without any reference to the particular condition of the soil to be treated and the special wants of the crops to be raised by their assistance.

To select judiciously from among the various brands of fertilizers offered for patronage requires, in the main, two kinds of information, namely, we ought to feel confident that the particular brand of fertilizer in question actually contains the guaranteed quantities and qualities of essential articles of plant food at a reasonable cost, and that it contains them in such form and such proportions as will best meet existing circumstances and special wants. In some cases it may be mainly either phosphoric acid or nitrogen or potash; in others, two of them; and in others again, all three. A remunerative use of commercial fertilizers can only be secured by attending carefully to the above-stated considerations.

To assist farmers not yet familiar with the current mode of determining the commercial value of manurial substances offered for sale in our markets, some of the essential considerations, which serve as a basis for their commercial valuation, are once more stated within a few subsequent pages.

The hitherto customary valuation of manurial substances is based on the average trade value of the essential fertilizing elements specified by analysis. The money value of the higher grades of agricultural chemicals and of the higher-priced compound fertilizers depends, in the majority of cases, on the amount and the particular form of two or three essential articles of plant food, *i. e.*, phosphoric acid, nitrogen and potash, which they contain. To ascertain by this mode of valuation the approximate market value of a fertilizer (*i. e.*, the money worth of its essential fertilizing ingredients), we multiply the pounds per ton of nitrogen, etc., by the trade value per pound; the same course is adopted with reference to the various forms of phosphoric acid and of potassium oxide. We thus get the values per ton of the several ingredients, and, adding them together, we obtain the total valuation per ton in case of cash payment at points of general distribution.

The market value of low-priced materials used for manurial purposes, as salt, wood ashes, various kinds of lime, barn-yard manure, factory refuse and waste materials of different description, quite frequently does not stand in a close relation to the market value of the amount of essential articles of plant food they contain. Their cost varies in different localities. Local facilities for cheap transportation, and more or less advantageous mechanical condition for a speedy action, exert, as a rule, a decided influence on their selling price.

The mechanical condition of any fertilizing material, simple or compound, deserves the most serious consideration of farmers when articles of a similar chemical character are offered for their choice. The degree of pulverization controls, almost without exception, under similar conditions, the rate of solubility, and the more or less rapid diffusion of the different articles of plant food throughout the soil.

The state of moisture exerts a no less important influence on the pecuniary value in case of one and the same kind of substance. Two samples of fish fertilizers, although equally pure, may differ from fifty to one hundred per cent. in commercial value on account of mere difference in moisture.

Crude stock for the manufacture of fertilizers, and refuse materials of various descriptions, have to be valued with reference to the market price of their principal constituents, taking into consideration at the same time their general fitness for speedy action.

Trade Values of Fertilizing Ingredients in Raw Materials and Chemicals, 1894.

	Cents per Pound.
Nitrogen in ammonia salts,	19
Nitrogen in nitrates,	14½
Organic nitrogen in dry and fine-ground fish, meat, blood, and in high-grade mixed fertilizers,	18½
Organic nitrogen in cotton-seed meal, linseed meal and castor pomace,	15
Organic nitrogen in fine-ground bone and tankage,	16½
Organic nitrogen in fine-ground medium bone and tankage,	15

Trade Values of Fertilizing Ingredients, etc. — Concluded.

	Cents per Pound.
Organic nitrogen in medium bone and tankage,	12
Organic nitrogen in coarse bone and tankage,	7
Organic nitrogen in hair, horn shavings and coarse fish scraps,	7
Phosphoric acid soluble in water,	6
Phosphoric acid soluble in ammonium citrate,	5½
Phosphoric acid in fine bone and tankage,	5½
Phosphoric acid in fine medium bone and tankage,	4½
Phosphoric acid in medium bone and tankage,	3
Phosphoric acid in coarse bone and tankage,	2
Phosphoric acid in fine-ground fish, cotton-seed meal, linseed meal, castor pomace and wood ashes,	5
Phosphoric acid insoluble (in ammonium citrate) in mixed fertilizers,	2
Potash as high-grade sulphate, and in mixtures free from muriate,	5¼
Potash as muriate,	4½

The manurial constituents contained in feed stuffs are valued as follows: —

	Cents per Pound.
Organic nitrogen,	15
Phosphoric acid,	5
Potash,	5

The organic nitrogen in *superphosphates, special manures and mixed fertilizers of a high grade* is usually valued at the highest figures laid down in the trade values of fertilizing ingredients in raw materials, namely, fifteen and a half cents per pound; it being assumed that the organic nitrogen is derived from the best sources, viz., animal matter, as meat, blood, bones or other equally good forms, and not from leather, shoddy, hair or any low-priced, inferior form of vegetable matter, unless the contrary is ascertained. The insoluble phosphoric acid is valued in this connection at two cents.

The above trade values are the figures at which, in the six months preceding March, 1894, the respective ingredients could be bought at *retail for cash in our large markets, in the raw materials,* which are the regular source of supply.

They also correspond to the average wholesale prices for the six months ending March 1, plus about twenty per cent.

in case of goods for which we have wholesale quotations. The valuations obtained by use of the above figures will be found to agree fairly with the retail price at the large markets of standard raw materials, such as: —

Sulphate of ammonia,
Nitrate of soda,
Muriate of potash,
Sulphate of potash,
Dried blood,
Dried ground meat,
Dry ground fish,
Azotin,
Ammonite,
Castor pomace,
Bone and tankage,
Plain superphosphates.

A large percentage of commercial materials consists of refuse matter from various industries. The composition of these substances depends on the mode of manufacture carried on. The rapid progress in our manufacturing industries is liable to affect at any time, more or less seriously, the composition of the refuse. To assist the farming community in a clear and intelligent appreciation of the various substances sold for manurial purposes, a frequent examination into the temporary characters of agricultural chemicals and refuse materials offered in our markets for manurial purposes is constantly carried on at the laboratory of the station.

Consumers of commercial manurial substances do well to buy, whenever practicable, on guarantee of composition with reference to their essential constituents, and to see to it that the bill of sale recognizes that point of the bargain. Any mistake or misunderstanding in the transaction may be readily adjusted, in that case, between the contending parties. The responsibility of the dealer ends with furnishing an article corresponding in its composition with the lowest stated quantity of each specified essential constituent.

Our present laws for the regulation of the trade in commercial fertilizers include not only the various brands of compound fertilizers, but also all materials, single or compound, without reference to source, used for manurial purposes when offered for sale in our market at ten dollars or more per ton. Copies of our present laws for the regulation of the trade in commercial fertilizers may be had by all interested, on application at the Massachusetts State Agricultural Experiment Station, Amherst, Mass.

2. THE PROVISIONS OF THE ACT ARE AS FOLLOWS:

[CHAPTER 296.]

AN ACT TO REGULATE THE SALE OF COMMERCIAL FERTILIZERS.

Be it enacted, etc., as follows:

SECTION 1. Every lot or parcel of commercial fertilizer or material used for manurial purposes sold, offered or exposed for sale within this Commonwealth, the retail price of which is ten dollars or more per ton, shall be accompanied by a plainly printed statement clearly and truly certifying the number of net pounds of fertilizer in the package, the name, brand or trade mark under which the fertilizer is sold, the name and address of the manufacturer or importer, the place of manufacture, and a chemical analysis stating the percentage of nitrogen or its equivalent in ammonia, of potash soluble in distilled water, and of phosphoric acid in available form soluble in distilled water and reverted, as well as the total phosphoric acid. In the case of those fertilizers which consist of other and cheaper materials, said label shall give a correct general statement of the composition and ingredients of the fertilizer it accompanies.

SECT. 2. Before any commercial fertilizer, the retail price of which is ten dollars or more per ton, is sold, offered or exposed for sale, the importer, manufacturer or party who causes it to be sold or offered for sale within the state of Massachusetts, shall file with the director of the Massachusetts agricultural experiment station, a certified copy of the statement named in section one of this act, and shall also deposit with said director at his request a sealed glass jar or bottle, containing not less than one pound of the fertilizer, accompanied by an affidavit that it is a fair average sample thereof.

SECT. 3. The manufacturer, importer, agent or seller of any brand of commercial fertilizer or material used for manurial purposes, the retail price of which is ten dollars or more per ton, shall pay for each brand, on or before the first day of May annually, to the director of the Massachusetts agricultural experiment station, an analysis fee of five dollars for each of the three following fertilizing ingredients: namely, nitrogen, phosphorus and potassium, contained or claimed to exist in said brand or fertilizer: *provided*, that whenever the manufacturer or importer shall have paid the fee herein required for any person acting as agent or seller for such manufacturer or importer, such agent or seller shall not be required to pay the fee named in this section; and on receipt of said analysis fees and statement specified in section two, the director of said station shall issue certificates of compliance with this act.

SECT. 4. No person shall sell, offer or expose for sale in the state of Massachusetts, any pulverized leather, raw, steamed, roasted, or in any form as a fertilizer, or as an ingredient of any fertilizer or manure, without an explicit printed certificate of the fact, said certificate to be conspicuously affixed to every package of such fertilizer or manure and to accompany or go with every parcel or lot of the same.

SECT. 5. Any person selling, offering or exposing for sale, any commercial fertilizer without the statement required by the first section of this act, or with a label stating that said fertilizer contains a larger percentage of any one or more of the constituents mentioned in said section than is contained therein, or respecting the sale of which all the provisions of the foregoing section have not been fully complied with, shall forfeit fifty dollars for the first offence, and one hundred dollars for each subsequent offence.

SECT. 6. This act shall not affect parties manufacturing, importing or purchasing fertilizers for their own use, and not to sell in this state.

SECT. 7. The director of the Massachusetts agricultural experiment station shall pay the analysis fees, as soon as received by him, into the treasury of the station, and shall cause one analysis or more of each fertilizer or material used for manurial purposes to be made annually, and publish the results monthly, with such additional information as circumstances advise: *provided*, such information relates only to the composition of the fertilizer or fertilizing material inspected. Said director is hereby authorized in person or by deputy to take a sample, not exceeding two pounds in weight, for analysis, from any lot or package of fertilizer or any material used for manurial purposes which may be in the possession of any manufacturer, importer, agent or dealer; but said sample shall be drawn in the presence of said party or parties in interest or their representative, and taken from a parcel or a number of packages which shall be not less than ten per cent. of the whole lot inspected, and shall be thoroughly mixed and then divided into two equal samples and placed in glass vessels and carefully sealed and a label placed on each, stating the name or brand of the fertilizer or material sampled, the name of the party from whose stock the sample was drawn and the time and place of drawing, and said label shall also be signed by the director or his deputy and by the party or parties in interest or their representatives present at the drawing and sealing of said sample; one of said duplicate samples shall be retained by the director and the other by the party whose stock was sampled. All parties violating this act shall be prosecuted by the director of said station; but it shall be the duty of said director, upon ascertaining any violation of this act, to forthwith notify the manufacturer or importer in writing, and give him not less than thirty days thereafter in which to comply with the requirements of this act, but there shall be no prosecution in relation to the quality of the fertilizer or fertilizing material if the same shall be found substantially equivalent to the statement of analysis made by the manufacturer or importer.

SECT. 8. Sections eleven to sixteen inclusive of chapter sixty of the Public Statutes are hereby repealed.

SECT. 9. This act shall take effect on the first day of September in the year eighteen hundred and eighty-eight. [*Approved May 3, 1888.*]

Instructions to Manufacturers, Importers, Agents and Sellers of Commercial Fertilizers or Materials used for Manurial Purposes in Massachusetts.

1. An application for a certificate of compliance with the regulations of the trade in commercial fertilizers and materials used for manurial purposes in this State must be accompanied: —

First, with a distinct statement of the name of each brand offered for sale.

Second, with a statement of the amount of phosphoric acid, of nitrogen and of potassium oxide guaranteed in each distinct brand.

Third, with the fee charged by the State for a certificate, which is five dollars for each of the following articles, nitrogen, phosphoric acid and potassium oxide, guaranteed in any distinct brand.

2. The obligation to secure a certificate applies not only to compound fertilizers but to all substances, single or compound, used for manurial purposes, and offered for sale at ten dollars or more per ton of two thousand pounds.

3. The certificate must be secured annually before the first of May.

4. Manufacturers, importers and dealers in commercial fertilizers can appoint in this State as many agents as they

desire, after having secured at this office the certificate of compliance with our laws.

5. Agents of manufacturers, importers and dealers in commercial fertilizers are held personally responsible for their transactions until they can prove that the articles they offer for sale are duly recorded in this office.

6. Manufacturers and importers are requested to furnish a list of their agents.

7. All applications for certificates should be addressed to the Director of the Massachusetts State Agricultural Experiment Station.

Arrangements are made, as in previous years, to attend to the examination of objects of general interest to the farming community, to the full extent of existing resources. Requests for analyses of substances — as fodder articles, fertilizers, etc. — coming through officers of agricultural societies and farmers' clubs within the State will receive hereafter, as in the past, first attention, and in the order that the applications arrive at the office of the station. The results will be returned without a charge for the services rendered. Application of private parties for analyses of substances, free of charge, will receive a careful consideration whenever the results promise to be of a more general interest. For obvious reasons, no work can be carried on at the station of which the results are not at the disposal of the managers for publication, if deemed advisable in the interest of the citizens of the State.

All parcels and communications sent to "The Massachusetts State Experiment Station" must have express and postal charges prepaid, to receive attention.

3. LIST OF MANUFACTURERS AND DEALERS WHO HAVE SECURED CERTIFICATES FOR THE SALE OF COMMERCIAL FERTILIZERS IN THIS STATE DURING THE PAST YEAR (MAY 1, 1894, TO MAY 1, 1895), AND THE BRANDS LICENSED BY EACH.

Allison, Stroup & Co., New York, N. Y.: —
Odorless Phosphate.
Canada Wood Ashes.

Ames Fertilizer Company, Peabody, Mass.: —
Plymouth Rock Brand.
Special Potato Fertilizer.
Strawberry Fertilizer.
Ground Bone.
Nitrate of Soda.
Sulphate of Potash.
Muriate of Potash.

H. J. Baker & Bro., New York, N. Y.: —
Special Potato Manure.
Special Grass Manure.
"A A" Ammoniated Superphosphate.
Special Tobacco Manure.
Special Corn Manure.
Standard A X C D Fertilizer.
Special Strawberry Manure.
Pure Ground Bone.
Nitrate of Soda.
Muriate of Potash.

C. A. Bartlett, Worcester, Mass.: —
Pure Ground Bone.
Animal Fertilizer.

J. L. Bonzey, Auburn, Mass.: —
Ground Bone.

Bowker Fertilizer Company, Boston, Mass.: —
Stockbridge Special Manures.
Bowker's Hill and Drill Phosphate.
Bowker's Farm and Garden Phosphate.
Bowker's Lawn and Garden Dressing.
Bowker's Fish and Potash.

Bowker Fertilizer Company, Boston, Mass. — *Concluded.*
- Bowker's Potato and Vegetable Manure.
- Bowker's Sure Crop Bone Phosphate.
- Gloucester Fish and Potash.
- Bowker's Dried Ground Fish.
- Bowker's Fresh Ground Fish.
- Nitrate of Soda.
- Dried Blood.
- Dissolved Bone-black.
- Muriate of Potash.
- Sulphate of Potash.

Bradley Fertilizer Company, Boston, Mass.: —
- X L Phosphate.
- Potato Manure.
- B D Sea Fowl Guano.
- Complete Manures.
- Fish and Potash.
- High-grade Tobacco Manure.
- English Lawn Fertilizer.
- Breck's Lawn and Garden Dressing.
- Circle Brand Bone and Potash.
- Eclipse Phosphate.
- Fine-ground Bone.
- Dissolved Bone-black.
- Sulphate of Ammonia.
- Nitrate of Soda.
- Muriate of Potash.
- Sulphate of Potash.

W. J. Brightman & Co., Tiverton, R. I.: —
- High-grade Potato and Root Manure.
- Superphosphate.
- Fish and Potash.
- Menhaden Fish Guano.

Bryant & Brett, New Bedford, Mass.: —
- Ground Bone.

Joseph Church & Co., Tiverton, R. I.: —
- Church's Fish and Potash.
- Church's "B" Special Fertilizer.
- Church's "C" Standard Fertilizer.

Clark's Cove Fertilizer Company, Boston, Mass.: —
Bay State Fertilizer.
Bay State Fertilizer, "G G."
King Philip Guano.
Potato and Tobacco.
Great Planet "A."
Bay State Potato Manure.
Tobacco Fertilizer.
Fish and Potash.
White Oak Pure Ground Bone.
Muriate of Potash.
Sulphate of Potash.
Nitrate of Soda.

Cleveland Dryer Company, Boston, Mass.: —
Corn and Grain Phosphate.
Cleveland Fertilizer.
Cleveland Potato Phosphate.
Cleveland Superphosphate.

Cleveland Linseed Oil Company, Cleveland, O.: —
Connecticut Wrapper Fertilizer.
Coarse Linseed Meal.

E. Frank Coe Company, New York, N. Y.: —
Alkaline Bone.
High-grade Ammoniated Bone Superphosphate.
Red Brand Excelsior.
Gold Brand Excelsior.
Special Tobacco Fertilizer.
High-grade Potato Fertilizer.
Fish and Potash.
Special Potato Fertilizer.

Crocker Fertilizer and Chemical Company, Buffalo, N. Y.: —
Ammoniated Bone Superphosphate.
Potato, Hop and Tobacco Phosphate.
Special Potato Manure.
Pure Ground Bone.
Ammoniated Practical Superphosphate.
Vegetable Bone Superphosphate.
New Rival Ammoniated Superphosphate.
Ammoniated Wheat and Corn Phosphate.
Lawn Fertilizer.
Ground Bone Meal.

Cumberland Bone Phosphate Company, Boston, Mass.: —
Concentrated Phosphate.
Cumberland Fertilizer.
Potato Phosphate.
Superphosphate.

L. B. Darling Fertilizer Company, Pawtucket, R. I.: —
Animal Fertilizer.
Extra Bone Phosphate.
Potato and Root Crop Manure.
Lawn and Garden Manure.
Tobacco Grower.
Pure Fine Bone.
Pure Dissolved Bone.

Davidge Manufacturing Company, New York, N. Y.: —
Special Favorite.
Wheat and Corn Phosphate.
Tobacco Fertilizer.
Vegetator.

John C. Dow & Co., Boston, Mass.: —
Dow's Nitrogenous Superphosphate.
Dow's Ground Bone Fertilizer.
Dow's Ground Bone.

Forest City Wood Ash Company, Boston, Mass.: —
Canada Unleached Wood Ashes.

Wm. E. Fyfe & Co., Clinton, Mass.: —
Wood Ashes (Star Brand).

Great Eastern Fertilizer Company, Rutland, Vt.: —
Great Eastern General for Grain and Grass.
Great Eastern Vegetable, Vine and Tobacco.
Great Eastern General, Oats, Buckwheat and Seeding-down.
Great Eastern Soluble Bone and Potash Fertilizer.

Hargraves Manufacturing Company, Fall River, Mass.: —
Ground Bone.

Edmund Hersey, Hingham, Mass.: —
Fine-ground Bone.

Thos. Hersom & Co., New Bedford, Mass.: —
Bone Meal.
Meat and Bone.

John G. Jefferds, Worcester, Mass.: —
  Animal Fertilizer.
  Potato Fertilizer.
  Ground Bone.

Thos. Kirley, South Hadley Falls, Mass.: —
  Pride of the Valley.

A. Lee & Co., Lawrence, Mass.: —
  Lawrence Fertilizer.

Lowe Bros. & Co., Fitchburg, Mass.: —
  Bone.

Lowell Bone Fertilizer Company, Lowell, Mass.: —
  Lowell Bone Fertilizer.

The Mapes Formula and Peruvian Guano Company, New York, N. Y.: —
  The Mapes Bone Manures.
  Peruvian Guano.
  The Mapes Superphosphates.
  The Mapes Special Crop Manures.
  Sulphates of Potash.
  Economical Manure.
  Nitrate of Soda.

Mason, Chapin & Co., Providence, R. I.: —
  Odorless Chemical Compound Fertilizer.

James E. McGovern, Lawrence, Mass.: —
  West Andover Market Bone Phosphate.
  Ground Bone.

McQuade Bros., West Auburn, Mass.: —
  Ground Bone.

Munroe, Lalor & Co., Oswego, N. Y.: —
  Canada Wood Ashes.
  Swift's Ground Bone.

National Fertilizer Company, Bridgeport, Conn.: —
  Complete Fertilizers.
  Universal Phosphate.
  Fish and Potash.
  Ground Bone.

Pacific Guano Company, Boston, Mass.: —
- Pacific Guano.
- Potato Manure.
- Potato and Tobacco Fertilizer.
- Fish and Potash.
- High-grade General Fertilizer.

John J. Peters, Long Island City, N. Y.: —
- Sheep Fertilizers.

Powers, Gibbs & Co.: —
- Special Potato Guano.
- X X X X X Peerless Ammoniated Guano.
- Sea Bird Ammoniated Guano.

Prentiss, Brooks & Co., Holyoke, Mass.: —
- Complete Manure.
- Phosphate.
- Nitrate of Soda.
- Muriate of Potash.
- Sulphate of Potash.
- Tankage.
- Dissolved Bone-black.

Preston Fertilizer Company, Greenpoint, L. I.: —
- Potato Fertilizer.
- Ammoniated Bone Superphosphate.

Quinnipiac Company, Boston, Mass.: —
- Quinnipiac Phosphate.
- Quinnipiac Potato Manure.
- Quinnipiac Market-garden Manure.
- Quinnipiac Fish and Potash, Crossed Fishes.
- Quinnipiac Fish and Potash, Plain Brand.
- Quinnipiac Potato and Tobacco Fertilizer.
- Quinnipiac Havana Tobacco Fertilizer.
- Quinnipiac Corn Manure.
- Quinnipiac Grass Fertilizer.
- Quinnipiac Bone Meal.
- Quinnipiac Dry Ground Fish.
- Quinnipiac Onion Manure.
- Ammoniated Dissolved Bone-black.
- Muriate of Potash.
- Sulphate of Potash.
- Sulphate of Ammonia.

Quinnipiac Company, Boston, Mass. — *Concluded.*
Nitrate of Soda.
Dissolved Bone-black.
Tankage.

Read Fertilizer Company, New York, N. Y. : —
Read's Standard.
High-grade Farmer's Friend.
Fish and Potash.
Vegetable and Vine.

John S. Reese & Co., Baltimore, Md. : —
Potato Special.
New England Favorite.
Pilgrim.

N. Roy & Son, South Attleborough, Mass. : —
Animal Fertilizer.

Lucien Sanderson, New Haven, Conn. : —
Formula "A."
Formula "B."
High-grade Sulphate of Potash.
Regular Sulphate of Potash.

Edward H. Smith, Northborough, Mass. : —
Fine-ground Bone.

Springfield Provision Company, Brightwood, Mass. : —
Blood, Meat and Bone.

Standard Fertilizer Company, Boston, Mass. : —
Complete Manure.
Standard Guano.
Potato and Tobacco Fertilizer.
Standard Fertilizer.
Standard Superphosphate.

T. L. Stetson, Randolph, Mass. : —
Fine-ground Bone.

F. C. Sturtevant, Hartford, Conn. : —
Tobacco and Sulphur Fertilizer.

Henry F. Tucker, Boston, Mass. : —
Original Bay State Bone Superphosphate.
Imperial Bone Superphosphate.
Special Potato Fertilizer.

Walker, Stratman & Co., Pittsburg, Pa.: —
- Potato Special.
- Tobacco Special.
- Banner.
- Four Fold.

M. E. Wheeler & Co., Rutland, Vt.: —
- Corn Fertilizer.
- Potato Manure.
- Grass and Oats Fertilizer.
- Electrical Dissolved Bone.

Whittemore Bros., Wayland, Mass.: —
- Whittemore's Complete Manure.

Leander Wilcox, Mystic, Conn.: —
- Potato, Onion and Tobacco Manure.
- Ammoniated Bone Superphosphate.
- High-grade Fish and Potash.
- Dry Ground Fish.

Williams & Clark, Boston, Mass.: —
- Potato Phosphate.
- Grass Manure.
- High-grade Special.
- Americus Corn Phosphate.
- Americus Potato and Tobacco Manure.
- Universal Ammoniated Dissolved Bones.
- Prolific Crop Producer.
- Americus Fish and Potash.
- Fish and Potash, No. 1.
- Royal Bone Phosphate.
- Onion Manure.
- Americus Ammoniated Bone Superphosphate.
- Dry Ground Fish.
- Pure Bone Meal.
- Tobacco Fertilizer.
- Tankage.
- Muriate of Potash.
- Sulphate of Potash.
- Nitrate of Soda.
- Sulphate of Ammonia.
- Dissolved Bone-black.
- Double Sulphate of Potash.

4. ANALYSES OF LICENSED FERTILIZERS COLLECTED DURING 1894 IN THE GENERAL MARKETS BY THE AGENT OF THE MASSACHUSETTS STATE AGRICULTURAL EXPERIMENT STATION.

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at —
	Compound Fertilizers.		
7	Lowell Bone Fertilizer,	J. W. Butman, Lowell, Mass.,	Amherst.
15	Blood, Bone and Meat,	Quinnipiac Fertilizer Company, Boston, Mass.,	Sunderland.
17	Blood, Bone and Meat,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
22	Corn Manure,	Quinnipiac Fertilizer Company, Boston, Mass.,	Sunderland.
27	Complete Manure for Corn and Grain,	Bradley Fertilizer Company, Boston, Mass.,	Worcester.
29	Potato Manure,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Worcester.
30	Complete Manure for General Use,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Worcester.
31	Animal Fertilizer,	C. A. Bartlett, Worcester, Mass.,	Worcester.
32	Potato Manure,	J. G. Jefferds, Worcester, Mass.,	Worcester.
35	Potato Manure,	Bradley Fertilizer Company, Boston, Mass.,	Worcester.
40	X L Superphosphate,	Bradley Fertilizer Company, Boston, Mass.,	Springfield.
41	Corn Manure,	Quinnipiac Fertilizer Company, Boston, Mass.,	Springfield.
42	Potato Manure,	Quinnipiac Fertilizer Company, Boston, Mass.,	Springfield.
43	Crossed Fish and Potash,	Quinnipiac Fertilizer Company, Boston, Mass.,	Springfield.
53	Dry Ground Fish,	Williams & Clark Fertilizer Company, Boston, Mass.,	Sunderland.

55	Vegetable, Vine and Tobacco Fertilizer,	Great Eastern Fertilizer Company, Rutland, Vt,	Sunderland.
60	High-grade Special,	Williams & Clark Fertilizer Company, Boston, Mass.,	Sunderland.
62	Complete Tobacco Fertilizer,	National Fertilizer Company, Bridgeport, Conn,	Hadley.
63	Chittenden's Fish and Potash,	National Fertilizer Company, Bridgeport, Conn.,	Hadley.
67	Dry Ground Fish,	Williams & Clark Fertilizer Company, Boston, Mass.,	Hadley.
68	Complete Corn Manure,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
69	Ground Tankage,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
73	Complete Grass Manure,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
76	Superphosphate,	Prentiss, Brooks & Co, Holyoke, Mass.,	Holyoke.
79	Blood, Meat and Bone,	Springfield Provision Company, Brightwood, Mass.,	Brightwood.
99	Fish and Potash,	Wm. J. Brightman & Co., Tiverton, R. I.,	Dighton.
120	Complete Manure for Corn and Grass,	Bradley Fertilizer Company, Boston, Mass.,	Boston.
127	Animal Fertilizer,	C. A. Bartlett, Worcester, Mass.,	Boston.
141	Potato Special,	H. F. Tucker, Boston, Mass.,	Taunton.
149	Complete Tobacco Manure,	National Fertilizer Company, Bridgeport, Conn.,	Deerfield.
166	Tobacco Fertilizer,	Davidge Fertilizer Company, New York, N. Y.,	Westfield.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.	Guaranteed.
								Found.	Guaranteed.	Found.	Guaranteed.		
	Compound Fertilizers.												
7	Lowell Bone Fertilizer,	10.32	2.55	2	-	7.84	.67	8.51	8	7.84	-	2.94	2
15	Blood, Bone and Meat,	11.36	8.25	6.59—8.24	.08	6.08	2.92	9.08	10—12	6.16	-	-	-
17	Blood, Bone and Meat,	6.49	4.94	5.77—7.41	,38	11.44	5.40	17.22	10—12	11.82	-	-	-
22 41	Corn Manure,	15.65	2.42	2.06—2.88	6.24	4.87	1.79	12.90	10—14	11.11	9—12	3.18	1.50—2.50*
27 120	Complete Manure for Corn and Grain,	9.38	3.81	3.30—4.12	3.04	8.16	4.81	16.01	13—15	11.20	12—14	2.98	3—4*
29	Potato Manure,	7.99	3.60	3.71—4.12	4.91	4.91	.67	10.49	8—10	9.82	8	8.20	6—8*
30	Complete Manure for General Use,	11.71	3.33	3.30—4.12	4.98	4.41	.90	10.29	10—12	9.39	-	5.40	4—5
31 127	Animal Fertilizer,	6.08	2.78	3.30—4.12	3.74	8.52	1.66	13.92	13—15	12.26	-	8.26	7—8
32	Potato Manure,	9.85	2.28	2.47—3.30	4.72	6.54	2.82	14.08	15—17	11.26	10—12	5.48	5—6
35	Potato Manure,	12.82	2.82	2.5—3.25	2.81	4.00	2.20	9.01	8—11	6.81	6—8	5.12	5—6
40	X L Superphosphate,	14.23	2.77	2.50—3.25	6.52	2.76	1.80	11.08	11—14	9.28	9—11	2.08	2—3*

42	Potato Manure,	13.10	2.50	2.47—3.30	3.33	5.21	.77	9.31	7—11	8.54	6—9	7.26	5—6*
43	Crossed Fish and Potash,	16.10	3.92	3.30—4.12	4.61	1.14	1.41	7.16	5—8	5.75	3—5	5.08	3—5*
53 67	Dry Ground Fish,	11.49	7.58	7.41—9.06	.74	5.78	1.51	8.03	7—9	6.52	-	-	-
55	Vegetable, Vine and Tobacco Fertilizer,	14.70	2.82	2.06—2.51	6.98	1.01	1.46	9.45	9—15	7.99	8—12	6.35	6—8
60	High grade Special,	12.41	3.95	3.7—4.12	5.23	2.86	1.20	9.29	8—11	8.09	7—9	7.43	7—9
62 149	Complete Tobacco Manure,	10.28	3.41	3.30—4.94	6.19	5.37	1.23	12.79	10—12	11.56	8—10	5.48	5.40—6.48
63	Chittenden's Fish and Potash,	8.73	2.92	2.88—3.71	3.79	3.83	1.69	9.31	6—8	7.62	-	4.45	5—6
68	Complete Corn Manure,	10.52	3.24	3.30—4.12	5.17	2.71	3.94	11.82	8—10	7.88	6—8	7.33	6—8
69	Ground Tankage,	8.91	7.73	7.41—7.83	.65	5.74	1.16	7.55	8—9	6.39	-	-	-
73	Complete Grass Manure,	5.93	4.89	4.12—4.94	2.20	2.86	3.84	8.90	7—8	5.06	4—5	8.42	7—9
76	Superphosphate,	12.60	2.74	2.06—2.47	9.52	.86	3.74	14.12	10—12	10.38	8—10	2.81	2.5—3
79	Blood, Meat and Bone,	8.08	8.13	7—8	.35	5.98	1.36	7.69	9.5—10.5	6.33	-	-	-
99	Fish and Potash,	18.10	2.91	2.07—2.88	3.48	3.53	1.18	8.19	7.5—10.5	7.01	6—8	2.45	2—3
141	Potato Special,	10.27	2.78	2.40	6.75	1.80	1.79	10.34	9—13	8.55	8—11	5.40	6—7
166	Tobacco Fertilizer,	12.25	1.70	3.30—4.12	10.36	1.66	1.54	13.56	-	12.02	9—10	1.24	3.79—5.05

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* Sulphate of potash, the source of potash.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
152	Fish and Potash,	Clark Cove Fertilizer Company, Boston, Mass,	Deerfield.
170	Standard Unexcelled Fertilizer,	H. J. Baker & Bro., New York, N. Y.,	Pittsfield.
172	Ammoniated Bone Superphosphate,	E. Frank Coe Fertilizer Company, New York, N. Y.,	Westfield.
176	High-grade Fish Guano and Potash,	E. Frank Coe Fertilizer Company, New York, N. Y.,	Westfield.
179	Potato, Hop and Tobacco Fertilizer,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Westfield.
182	Bay State Fertilizer,	Clark Cove Fertilizer Company, Boston, Mass.,	Greenfield.
187	Tobacco Manure,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Greenfield.
202	Animal Fertilizer,	N. Roy & Son, North Attleborough, Mass,	Amherst.
266	Tobacco Grower,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Sunderland.
	Chemicals.		
12	Electrical Dissolved Bone,	M. E. Wheeler & Co., Rutland, Vt.,	Amherst.
14	Dissolved Bone-black,	Quinnipiac Fertilizer Company, Boston, Mass.,	Sunderland.
18	Sulphate of Potash and Magnesia,	Quinnipiac Fertilizer Company, Boston, Mass.,	Sunderland.
19	Dissolved Bone-black,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
21	Sulphate of Potash and Magnesia,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
36	Sulphate of Potash and Magnesia,	Quinnipiac Fertilizer Company, Boston, Mass.,	Springfield.
46	Sulphate of Ammonia,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.

47	Nitrate of Soda,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
58	Muriate of Potash,	Williams & Clark Fertilizer Company, Boston, Mass.,	Sunderland.
61	Sulphate of Potash,	National Fertilizer Company, Bridgeport, Conn.,	Hadley.
66	Sulphate of Potash,	Williams & Clark Fertilizer Company, Boston, Mass.,	Hadley.
70	Dissolved Bone-black,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
92	Nitrate of Soda,	Bowker Fertilizer Company, Boston, Mass.,	Fall River.
145	Sulphate of Potash and Magnesia,	H. J. Baker & Bro., New York, N. Y.,	South Deerfield.
146	Dissolved Bone-black,	H. J. Baker & Bro., New York, N. Y.,	South Deerfield.
208	Muriate of Potash,	Clark Cove Fertilizer Company, Boston, Mass.,	Hudson.
	Bones.		
6	Steamed Fine Bone,	E. H. Smith, Northborough, Mass.,	Amherst.
8	Fine-ground Bone,	McQuade Bros., West Auburn, Mass,	Amherst.
28	Steamed Fine Bone,	E. H. Smith, Northborough, Mass.,	Worcester.
77	Fine-ground Bone,	McQuade Bros., West Auburn, Mass.,	West Auburn.
90	Ground Bone,	John C. Dow & Co., Boston, Mass.,	Amherst.
214	Ground Bone,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Fitchburg.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	NAME OF BRAND.	Moisture.	NITROGEN IN ONE HUNDRED POUNDS.		PHOSPHORIC ACID IN ONE HUNDRED POUNDS.							POTASSIUM OXIDE IN ONE HUNDRED POUNDS.	
								TOTAL.		AVAILABLE.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
152	Fish and Potash,	15.00	2.81	2.06—2.88	4.35	2.66	1.38	8.39	7—11	7.01	6—8	2.43	2—3
170	Standard Unexcelled Fertilizer,	13.93	2.72	2.06—2.26	8.14	.53	1.05	9.72	-	8.67	8—10	2.82	2—3
172	Ammoniated Bone Superphosphate,	10.05	2.73	2	7.01	2.82	3.17	13.00	11—15	9.83	9—12	2.67	1.85
176	High-grade Fish Guano and Potash,	7.15	2.63	2.47—3.30	2.56	2.45	3.48	8.49	7—11	5.01	6—9	3.39	2.75*
179	Potato, Hop and Tobacco Fertilizer,	14.03	2.07	2—3	7.01	3.30	1.33	11.64	11—14	10.31	10—12	3.84	3.25—4.30
182	Bay State Fertilizer,	12.83	2.60	2.47—3.30	5.35	3.18	1.91	10.44	10—14	8.53	9—12	2.80	2—3
187	Tobacco Manure,	6.09	5.62	6.18	-	5.40	.15	5.55	4—5	5.40	-	12.34	10.5
202	Animal Fertilizer,	4.07	4.28	4.28	.13	11.54	.28	11.95	11.95	11.67	-	-	-
266	Tobacco Grower,	8.89	4.22	4.94—5.77	.97	4.71	1.33	7.01	10—12	5.68	-	9.73	10.80
	Chemicals.												
12	Electrical Dissolved Bone,	13.95	-	-	7.82	5.06	.58	13.46	15—20	12.88	13—17	-	-
14	Dissolved Bone-black,	12.63	-	-	12.84	2.51	.77	16.12	16—18	15.35	-	-	-
18 36	Sulphate of Potash and Magnesia,	3.54	-	-	-	-	-	-	-	-	-	27.16	27.02—29.72
19	Dissolved Bone-black,	15.36	-	-	16.88	-	-	16.88	16—18	16.88	16.18	-	-

21	Sulphate of Potash and Magnesia,	3.95	-	-	-	-	-	-	-	-	-	29.44	27.02—29.72			
46	Sulphate of Ammonia,	.73	20.55	19.78—20.60	-	-	-	-	-	-	-	-	-			
47 92	Nitrate of Soda,	1.00	15.79	15.64—15.97	-	-	-	-	-	-	-	-	-			
58	Muriate of Potash,	1.34	-	-	-	-	-	-	-	-	-	50.44	50.54—53.70			
61	Sulphate of Potash,	1.10	-	-	-	-	-	-	-	-	-	49.92	-			
66	Sulphate of Potash,	.75	-	-	-	-	-	-	-	-	-	48.16	48.64—51.34			
70	Dissolved Bone-black,	12.16	-	-	15.51	-	2.00	17.50	16—17	15.51	16	-	-			
145	Sulphate of Potash and Magnesia,	5.89	-	-	-	-	-	-	-	-	-	25.80	25.94—28.10			
146	Dissolved Bone-black,	15.97	-	-	15.81	.44	.36	16.61	-	16.25	15—16	-	-			
208	Muriate of Potash,	1.42	-	-	-	-	-	-	-	-	-	50.04	50.54—53.70			
												Mechanical Analysis.				
	Bones.											Fine.	Med. Fine.	Med.	Coarse Med.	
6 28	Steamed Fine Bone,	4.91	4.09	4.02	.30	18.63	2.93	21.86	23	18.98	7.69	23.80	47.32	28.88	-	
8 77	Fine-ground Bone,	3.29	2.73	2.78	.05	22.82	1.64	24.51	24.52	22.87	16.74	47.07	23.63	18.00	11.30	
90	Ground Bone,	2.14	1.65	1.65—2.47	.20	25.84	2.05	28.09	24—26	26.04	-	60.67	39.33	-	-	
214	Ground Bone,	6.08	3.93	2.90—3.70	.26	16.32	3.67	25.25	25	16.58	-	43.87	25.66	22.60	7.87	

* Sulphate of potash, the source of potash.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at—
	Compound Fertilizers.		
3	Banner Fertilizer,	Walker, Stratman & Co., Pittsburg, Pa.,	Amherst.
9	Corn Fertilizer,	M. E. Wheeler & Co., Rutland, Vt.,	Amherst.
20	Pulverized Bone and Meat,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
37	Ammoniated Bone Superphosphate, "Americus,"	Williams & Clark Fertilizer Company, Boston, Mass.,	Springfield.
38	Quinnipiac Phosphate,	Quinnipiac Fertilizer Company, Boston, Mass.,	Springfield.
65	Ammoniated Bone Superphosphate,	National Fertilizer Company, Bridgeport, Conn.,	Hadley.
81	Hill and Drill Phosphate,	Bowker Fertilizer Company, Boston, Mass.,	Springfield.
82	Lawn and Garden Dressing,	Bowker Fertilizer Company, Boston, Mass.,	Springfield.
85	Potato and Vegetable,	Bowker Fertilizer Company, Boston, Mass.,	Springfield.
89	Ground Bone Fertilizer,	John C. Dow & Co., Boston, Mass.,	Amherst.
93	Corn Fertilizer,	M. E. Wheeler & Co., Rutland, Vt.,	Bridgewater.
94	Wood Ashes,	Forest City Wood Ash Company, London, Ont.,	Boston.
95	Special Potato Fertilizer,	Ames Fertilizer Company, Peabody, Mass.,	Dighton.
97	Potato and Root Crop Manure,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Somerset.
98	Potato Manure,	H. J. Baker & Bro., New York, N. Y.,	Fall River.
104	Animal Fertilizer,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Bridgewater.
105	Standard Fertilizer,	Standard Fertilizer Company, Boston, Mass.,	Whitman.

106	Vegetable, Vine and Fruit,	Read Fertilizer Company, Syracuse, N. Y.,	Bridgewater.
110	Pure Dry Ground Fish,	Joseph Church & Co., Tiverton, R. I.,	Dighton.
111	English Lawn Dressing,	Bradley Fertilizer Company, Boston, Mass.,	Whitman.
113	Fish and Potash, "B Brand,"	Bradley Fertilizer Company, Boston, Mass.,	Bridgewater.
114	Brightman's Phosphate,	Wm. J. Brightman & Co., Tiverton, R. I.,	West Bridgewater.
161	Potato Fertilizer,	Preston Fertilizer Company, Greenpoint, L. I.,	Lanesborough.
164	Potato Fertilizer,	Preston Fertilizer Company, Greenpoint, L. I.,	Lanesborough.
190	Ammoniated Bone Superphosphate, "Americus,"	Williams & Clark Fertilizer Company, Boston, Mass.,	Greenfield.
261	Banner Fertilizer,	Walker, Stratman & Co., Pittsburg, Pa.,	Leeds.
	Chemicals.		
45	Dissolved Bone-black,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
56	Dissolved Bone-black,	Williams & Clark Fertilizer Company, Boston, Mass.,	Sunderland.
107	Dissolved Bone-black,	Bowker Fertilizer Company, Boston, Mass.,	Fall River.
108	Nitrate of Soda,	Ames Fertilizer Company, Peabody, Mass.,	Dighton.
201	Dissolved Bone-black,	Clark Cove Fertilizer Company, Boston, Mass.,	Hudson.
220	Dissolved Bone-black,	Bradley Fertilizer Company, Boston, Mass.,	Amesbury.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	NAME OF BRAND.	Moisture.	NITROGEN IN ONE HUNDRED POUNDS.		PHOSPHORIC ACID IN ONE HUNDRED POUNDS.							POTASSIUM OXIDE IN ONE HUNDRED POUNDS.	
								TOTAL.		AVAILABLE.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
3 261	Banner Fertilizer,	9.62	2.65	2.06—2.88	5.32	2.13	2.00	9.45	11—12	7.45	9—10	1.62	1—2*
9 93	Corn Fertilizer,	13.65	2.88	1.65—2.47	4.64	3.22	1.64	9.50	9—14	7.86	8—12	2.45	1.65—2.47*
20	Pulverized Bone and Meat,	7.29	5.21	5.77—6.59	.30	11.99	5.58	17.87	18—20	12.29	-	-	-
37 190	Ammoniated Bone Superphosphate, "Americus,"	13.88	2.63	2.47—3.30	6.26	2.82	2.18	11.26	10—13	9.08	9—11	2.70	2—3
38	Quinnipiac Phosphate,	15.13	2.92	2.47—3.30	6.00	3.47	.84	10.31	10—14	9.47	9—12	2.73	2—3*
65	Ammoniated Bone Superphosphate,	14.82	2.48	1.65—2.06	.82	7.60	2.51	10.93	9—11	8.42	7—9	3.25	2—4
81	Hill and Drill Phosphate,	13.53	2.80	2.50—3.50	5.22	4.04	3.28	12.54	12—13	9.26	9—11	2.35	2—3
82	Lawn and Garden Dressing,	9.32	4.86	3.25—4.25	5.63	1.95	3.17	10.75	8—10	7.58	6—8	5.54	5—6
85	Potato and Vegetable,	12.20	3.28	3.25—4.25	6.14	2.82	1.89	10.85	8—10	8.96	6—8	6.92	7—8
89	Ground Bone Fertilizer,	6.66	2.20	2.06—2.47	.87	14.74	4.50	20.11	18—22	15.61	-	3.51	1.62—1.89
94	Wood Ashes,	11.59	-	-	-	-	-	1.13	1.5—2.5	-	-	5.28	4.5—8
95	Special Potato Fertilizer,	9.73	3.00	3—4	4.61	5.13	.79	10.53	9—13	9.74	8—11	9.00	7—9

97	Potato and Root Crop Manure, ...	9.43	2.76	2.88—4.12	3.48	6.24	1.74	11.46	10—12	9.72	6—8	6.57	7—9
98	Potato Manure, ...	10.99	4.01	3.30	4.52	1.77	.54	6.83	5.75	6.29	-	10.64	10
104	Animal Fertilizer, ...	13.21	3.06	3—4.5	3.89	4.25	.92	9.06	10—12	8.14	6—8	3.58	4—6
105	Standard Fertilizer, ...	15.07	2.20	2—3	5.76	2.56	2.30	10.62	10—15	8.32	8—12	2.18	2—3
106	Vegetable, Vine and Fruit, ...	12.01	1.84	1.65—2.47	4.55	3.13	.46	8.14	7—9	7.68	6—8	7.54	8—10
110	Pure Dry Ground Fish, ...	7.89	9.62	9.06—9.89	.10	6.70	1.69	8.49	6.87—9.16	6.80	-	-	-
111	English Lawn Dressing, ...	9.75	3.87	4.95—5.78	1.28	5.42	1.33	8.03	6—8	6.70	5—7	2.08	2.5—3.5
113	Fish and Potash, "B Brand,"	17.80	2.58	2.06—2.88	4.35	1.12	2.46	7.93	7.5—10.5	5.47	6—8	2.70	2—3
114	Brightman's Phosphate, ...	12.75	2.50	2.5—3.25	3.99	3.02	.67	7.68	8—11	6.01	6—8	5.72	5—6
161 164	Potato Fertilizer, ...	15.08	1.10	3.30—4.12	5.73	4.14	1.13	11.00	-	9.87	8—9	7.46	7—9
	Chemicals.												
45 107	Dissolved Bone-black, ...	13.75	-	-	14.67	.45	.33	15.45	18	15.12	15—18	-	-
56	Dissolved Bone-black, ...	12.52	-	-	12.13	3.12	.26	15.51	15—18	15.25	-	-	-
108	Nitrate of Soda, ...	1.50	15.02	15.5—16.5	-	-	-	-	-	-	-	-	-
201	Dissolved Bone-black, ...	10.99	-	-	11.90	3.86	.26	16.02	15—18	15.76	-	-	-
220	Dissolved Bone-black, ...	13.34	-	-	13.15	2.48	.64	16.27	15—18	15.63	-	-	-

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* Sulphate of potash, the source of potash.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilisers.		
140	Cleveland Superphosphate,	Cleveland Dryer Company, Boston, Mass.,	SouthFramingham.
151	Dry Ground Fish,	Quinnipiac Fertilizer Company, Boston, Mass.,	South Deerfield.
155	Ammoniated Bone Superphosphate,	Preston Fertilizer Company, Greenpoint, L. I.,	Pittsfield.
160	Ammoniated Bone Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	North Adams.
165	Fine-ground Bone and Potash, "Circle Brand,"	Bradley Fertilizer Company, Boston, Mass.,	Pittsfield.
171	Special Potato Fertilizer,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Westfield.
174	Ammoniated Bone Superphosphate,	Preston Fertilizer Company, Greenpoint, L. I.,	Lanesborough.
178	High-grade Tobacco Manure,	Bradley Fertilizer Company, Boston, Mass.,	Northampton.
181	Potato Phosphate,	Williams & Clark Fertilizer Company, Boston, Mass.,	Greenfield.
186	Complete Tobacco Fertilizer,	H. J. Baker & Bro., New York, N. Y.,	South Deerfield.
198	Cumberland Superphosphate,	Cumberland Bone Phosphate Company, Portland, Me.,	Hudson.
206	Potato Manure,	Clark Cove Fertilizer Company, Boston, Mass.,	Hudson.
211	Vegetable Bone Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Newburyport.
215	Special Potato Manure,	Pacific Guano Company, Boston, Mass.,	Newburyport.
226	Cumberland Superphosphate,	Cumberland Bone Phosphate Company, Portland, Me.,	Lawrence.
229	Alkaline Bone Phosphate,	E. Frank Coe, New York, N. Y.,	Framingham.
238	Blood, Bone and Meat,	Williams & Clark Fertilizer Company, Boston, Mass.,	Dalton.

258	Grass and Grain Fertilizer,	Great Eastern Fertilizer Company, Rutland, Vt.,	Westfield.
268	Fish and Potash,	Leander Wilcox, Mystic, Conn.,	Amherst.
	Bones.		
1	Pure Bone Meal,	Thomas Stetson, Randolph, Mass.,	Amherst.
78	Ground Bone,	John L. Bonzey, Auburn, Mass.,	Auburn.
83	Fresh Ground Bone,	Bowker Fertilizer Company, Boston, Mass.,	Springfield.
100	Pure Bone Meal,	Thomas Hersom & Co., New Bedford, Mass.,	New Bedford.
121	Pure Bone Meal,	Thomas Stetson, Randolph, Mass.,	Boston.
124	Fine-ground Bone,	Bradley Fertilizer Company, Boston, Mass.,	Boston.
131	Fine-ground Bone,	Hargraves Manufacturing Company, Fall River, Mass.,	Fall River.
189	Pure Bone Meal,	Quinnipiac Fertilizer Company, Boston, Mass.,	Williamstown.
233	Pure Ground Bone,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Haverhill.
239	Ground Bone,	John L. Bonzey, Auburn, Mass.,	Amherst.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	NAME OF BRAND.	Moisture.	NITROGEN IN ONE HUNDRED POUNDS.		PHOSPHORIC ACID IN ONE HUNDRED POUNDS.							POTASSIUM OXIDE IN ONE HUNDRED POUNDS.	
								TOTAL.		AVAILABLE.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
140	Cleveland Superphosphate,	14.13	3.46	2.05—2.95	4.61	4.75	2.10	11.46	11—14	9.36	9—11	2.06	2—3
151	Dry Ground Fish,	9.69	8.01	7.41—9.06	.87	4.24	1.59	6.70	7—9	5.11	-	-	-
155 174	Ammoniated Bone Superphosphate,	9.67	2.50	2.47—3.30	6.38	6.40	1.26	14.04	-	12.78	9—11	2.93	2—3
160	Ammoniated Bone Superphosphate,	10.21	3.40	2.90—3.70	7.50	2.68	.73	10.91	11—14	10.18	10—12	1.82	1—2
165	Fine-ground Bone and Potash, "Circle Brand,"	11.15	2.26	1.85—2.68	1.56	7.06	3.10	11.72	8—12	8.62	-	2.42	2—3
171	Special Potato Manure,	13.01	3.79	3.70—4.50	6.40	2.30	.46	9.16	9—11	8.70	8—9	5.67	5.40—6.40
178	High-grade Tobacco Manure,	6.26	6.04	5.77—6.59	.61	3.18	1.28	5.07	4—5	3.79	-	12.75	10.81—12.43*
181	Potato Phosphate,	17.92	2.78	2.47—3.30	4.25	2.50	1.28	8.03	7—11	6.75	6—9	4.60	5—6*
186	Complete Tobacco Manure,	7.59	4.88	4.53—5.36	4.09	.21	.87	5.17	-	4.30	3—5	10.65	10—12
198 226	Cumberland Superphosphate,	14.35	2.28	2.06—2.88	5.76	2.88	2.68	11.32	10—12	8.64	8—10	2.40	2—3*
206	Potato Manure,	10.48	2.44	2.47-3.30	3.48	3.33	2.15	8.96	7—11	6.81	6—9	4.79	5—6*
211	Vegetable Bone Superphosphate,	13.55	5.06	5—6	5.12	1.07	.82	7.01	7—9	6.19	6—7	6.34	6—8*

215	Special Potato Manure, ...	12.12	2.80	2.47—3.30	2.61	3.33	1.94	7.88	7—10	5.94	5–7	5.52		5—6*	
229	Alkaline Bone Phosphate, ...	9.70	1.50	1—1.5	6.40	1.37	3.74	11.51	10—14	7.77	9—12	2.69		1.62—2.16*	
238	Blood, Bone and Meat, ...	7.13	3.31	-	.46	7.42	2.87	10.75	-	7.88	-	-		-	
258	Grass and Grain Fertilizer, ...	14.94	2.46	2.88—3.71	6.29	1.74	1.18	9.21	9—15	8.03	8—12	3.49		2—4	
263	Fish and Potash, ...	14.37	3.48	3.25—4.25	2.66	3.94	.72	7.32	6—7	6.60	5—6	5.23		4—5	
	Bones.											MECHANICAL ANALYSIS.			
												Fine.	Med. Fine.	Med.	Coarse Med.
1 121	Pure Bone Meal, ...	8.70	3.96	3—4	.38	9.48	12.02	21.88	20—26	9.86	-	14.95	25.30	35.96	23.79
78 239	Ground Bone, ...	8.43	3.87	3.67	.30	16.74	3.68	20.72	20.72	17.04	-	42.30	37.60	15.00	5.10
83	Fresh Ground Bone, ...	8.94	2.88	2.47—3.30	.31	17.45	3.48	21.24	18—22	17.76	5–7	21.20	38.10	40.70	-
100	Pure Bone Meal, ...	4.95	1.88	2	.12	25.08	5.12	30.32	29.21	25.20	-	74.83	15.49	6.68	3.00
124	Fine-ground Bone, ...	7.10	3.60	2.5—3.25	.05	17.81	1.33	19.19	21—23	17.86	-	51.50	36.80	17.70	-
131	Fine-ground Bone, ...	7.71	3.48	2.5—2.8	.41	21.34	1.33	23.08	25—27	21.75	-	29.20	22.20	17.40	31.20
189	Pure Bone Meal, ...	4.62	2.65	2.47—4.12	.31	12.34	6.01	18.66	20–25	12.65	-	54.80	33.80	11.40	-
233	Pure Ground Bone, ...	7.67	4.80	2.88—3.71	-	14.34	8.44	22.78	24–26	14.34	-	17.64	25.90	25.12	31.34

* Sulphate of potash, the source of potash.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at —
	Compound Fertilizers.		
2	Potato Special,	Walker, Stratman & Co., Pittsburg, Pa.,	Amherst.
10	Potato Manure,	M. E. Wheeler & Co., Rutland, Vt.,	Amherst.
39	Market Garden Manure,	Quinnipiac Fertilizer Company, Boston, Mass.,	Springfield.
51	Odorless Phosphate,	Allison, Stroup & Co., Boston, Mass.,	Amherst.
84	Complete Top-dressing Manure,	Bowker Fertilizer Company, Boston, Mass.,	Springfield.
86	Fish and Potash, "D Brand,"	Bowker Fertilizer Company, Boston, Mass.,	Springfield.
87	Special Favorite,	Davidge Fertilizer Company, New York, N. Y.,	Monson.
96	Strawberry Manure,	H. J. Baker & Bro., New York, N. Y.,	Fall River.
102	Bristol Fish and Potash,	Bowker Fertilizer Company, Boston, Mass.,	Dighton.
103	Potato Manure,	M. E. Wheeler & Co., Rutland, Vt.,	Bridgewater.
109	Farm and Garden Phosphate,	Bowker Fertilizer Company, Boston, Mass.,	Dighton.
112	Standard Fertilizer,	Read Fertilizer Company, Syracuse, N. Y.,	West Bridgewater.
115	Potato and Root Fertilizer,	Wm. J. Brightman & Co., Tiverton, R. I.,	West Bridgewater.
116	High-grade Farmers' Friend,	Read Fertilizer Company, Syracuse, N. Y.,	West Bridgewater.
117	Lawn and Garden Dressing,	Bradley Fertilizer Company, Boston, Mass.,	Boston.
119	Sheep Fertilizer,	John J. Peters, Long Island City, N. Y.,	Boston.
123	Wood Ashes,	Allison, Stroup & Co., Boston, Mass.,	Boston.

129	A A Ammoniated Superphosphate,	H. J. Baker & Bro., New York, N. Y.,	Fall River.
133	Fish and Potash, "D Brand,"	Daniel T. Church & Co., Providence, R.I.,	Dighton.
137	Meat and Bone,	Thomas Hersom & Co , New Bedford, Mass.,	New Bedford.
138	Potato and Root Fertilizer,	W. J. Brightman & Co., Tiverton, R. I.,	Dighton.
139	Potato Phosphate,	Cleveland Dryer Company, Boston, Mass.,	South Framingham.
142	Bay State Bone Superphosphate,	H. F. Tucker, Boston, Mass.,	Taunton.
143	Plymouth Rock Brand,	Ames Fertilizer Company, Peabody, Mass.,	Dighton.
147	Ammoniated Dissolved Bone,	Quinnipiac Fertilizer Company, Boston, Mass.,	Williamstown.
148	Grass and Grain Fertilizer,	E. Frank Coe, New York, N. Y.,	Williamstown.
156	Dry Fish Guano,	Bradley Fertilizer Company, Boston, Mass.,	Northampton.
158	Potato Manure,	E. Frank Coe, New York, N. Y.,	Lee.
167	Special Favorite,	Davidge Fertilizer Company, New York, N. Y.,	Westfield.
250	Potato Special,	Walker, Stratman & Co., Pittsburg, Pa.,	Leeds.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	NAME OF BRAND.	Moisture.	NITROGEN IN ONE HUNDRED POUNDS.		PHOSPHORIC ACID IN ONE HUNDRED POUNDS.							POTASSIUM OXIDE IN ONE HUNDRED POUNDS.	
								TOTAL.		AVAILABLE.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
2 250	Potato Special, ...	12.01	1.54	2.47—3.30	6.45	2.20	1.94	10.59	12—18	8.65	10—11	6.12	5—6
10 103	Potato Manure, ...	12.80	2.12	2.06—2.88	5.07	3.27	1.38	9.72	9—15	8.34	8—12	6.46	3.75—4.50
39	Market-garden Manure, ...	11.46	3.78	3.30—4.12	3.74	5.83	1.02	10.59	9—13	9.57	8—11	7.02	7—8
51	Odorless Phosphate, ...	.39	-	-	-	-	-	20.84	18	-	-	-	-
64	Complete Top-dressing Manure, . . .	6.40	5.04	5—6	2.05	5.01	2.92	9.98	6—7	7.06	4—6	7.19	6—7
86	Fish and Potash, "D Brand,"	6.95	3.14	2.14—3.14	2.15	3.88	5.48	11.51	8—10	6.03	-	4.09	2—3
87 167	Special Favorite, ...	6.57	1.50	1.24—2.06	5.88	6.25	2.97	15.10	11—14	12.13	10—12	1.63	1.5—2.5*
96	Strawberry Manure, ...	12.25	2.77	2.88	2.89	4.13	1.30	8.32	6	7.02	-	9.04	8
102	Bristol Fish and Potash, ...	15.72	2.04	1.6—2.5	2.58	5.31	3.79	11.68	8—10	7.89	5—8	1.94	2—3
109	Farm and Garden Phosphate, ...	11.98	2.14	1.5—2.5	2.61	5.59	2.70	10.90	10—14	8.20	8—11	2.13	2—3
112	Standard Fertilizer, ...	14.12	1.17	.8	6.09	2.26	.72	9.06	9—12	8.34	8	4.36	4 - 6

115 138	Potato and Root Fertilizer,	10.71	3.72	3.73—4.52	4.30	4.68	1.82	10.80	9—12	8.98	8—11	5.83	6—7
116	High-grade Farmers' Friend,	11.20	3.34	3.30—4.12	4.61	1.54	1.07	7.22	6	6.15	5—6	10.86	10—11
117	Lawn and Garden Dressing,	7.22	3.30	4.12—4.94	1.82	4.27	1.59	7.68	-	6.09	5—6	5.54	5—6
119	Sheep Fertilizer,	13.44	2.14	1.65	-	-	-	1.59	1.20	-	-	1.64	1.70
123	Wood Ashes,	19.62	-	-	-	-	-	1.74	1.36—1.83	-	-	4.70	5.84—6.80
129	A A Ammoniated Superphosphate,	12.77	3.15	2.47—3.30	5.25	5.22	2.02	12.49	-	10.47	10—12	2.32	2—3
133	Fish and Potash, "D Brand,"	19.94	2.53	2.07—2.90	3.63	3.43	.92	7.98	7.50—10.50	7.06	6—8	2.48	2—3
137	Meat and Bone,	5.73	5.53	4.24	.72	10.36	7.96	19.04	19—25	11.08	-	-	-
139	Potato Phosphate,	13.83	1.96	2.05—2.85	3.17	6.48	1.61	11.26	10—13	9.65	8—10	3.56	3—4*
142	Bay State Bone Superphosphate,	11.85	2.02	2	6.04	2.98	2.70	11.72	11—15	9.02	9—12	2.08	1.85
143	Plymouth Rock Brand,	12.55	3.29	3.30—4.12	4.50	5.91	1.74	12.15	9—13	10.41	8—11	4.59	4—4.5
147	Ammoniated Dissolved Bone,	13.01	1.66	1.65—2.47	4.91	4.92	1.48	11.31	10—13	9.83	9—11	2.18	2—3
148	Grass and Grain Fertilizer,	12.12	1.30	.80—1.65	4.61	7.50	.84	13.05	10—13	12.11	9—11	1.66	1.35—1.90
156	Dry Fish Guano,	12.13	8.50	7.41—9.06	.87	4.30	.77	5.94	7—9	5.17	-	-	-
158	Potato Manure,	14.39	2.24	2—2.50	6.47	2.13	3.07	11.67	10—14	8.60	8—11	5.72	6—7

* Sulphate of potash, the source of potash.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at —
	Compound Fertilizers.		
168	Potato and Root Crop Manure,	Prentiss, Brooks & Co., Holyoke, Mass.,	Westfield.
169	Excelsior Tobacco Grower,	E. Frank Coe, New York, N. Y.,	Westfield.
173	Fish and Potash, "Plain Brand,"	Quinnipiac Fertilizer Company, Boston, Mass.,	Westfield.
175	Ground Bone and Potash,	E. Frank Coe, New York, N. Y.,	Lee.
177	Dry Ground Fish,	Bowker Fertilizer Company, Boston, Mass.,	Northampton.
184	Potato, Onion and Tobacco Grower,	Williams & Clark Fertilizer Company, Boston, Mass.,	Greenfield.
185	Fish and Potash, "Americus Brand,"	Williams & Clark Fertilizer Company, Boston, Mass.,	Greenfield.
194	West Andover Market Bone Phosphate,	James E. McGovern, West Andover, Mass.,	Lawrence.
195	Tobacco and Sulphur,	F. C. Sturtevant, Hartford, Conn.,	Fitchburg.
205	King Philip Guano,	Clark Cove Fertilizer Company, Boston, Mass.,	Lawrence.
218	Tankage and Bone,	Lowe Brothers & Co., Fitchburg, Mass.,	Fitchburg.
222	Royal Bone Phosphate,	Williams & Clark Fertilizer Company, Boston, Mass.,	Lowell.
228	Eclipse Phosphate,	Bradley Fertilizer Company, Boston, Mass.,	Newburyport.
230	Lawrence Fertilizer,	A. Lee & Co., Lawrence, Mass.,	Lawrence.
234	Potato and Tobacco Fertilizer,	Clark Cove Fertilizer Company, Boston, Mass.,	Lawrence.
235	Soluble Pacific Guano,	Pacific Guano Company, Boston, Mass.,	Newburyport.
237	West Andover Market Bone Phosphate,	James E. McGovern, Lawrence, Mass.,	Amherst.

241	Potato, Onion and Tobacco Fertilizer,	Leander Wilcox, Mystic, Conn.,	South Hadley Falls.
246	Potato and Tobacco Manure,	Standard Fertilizer Company, Boston, Mass.,	Ludlow.
247	Pride of the Valley,	Kirley Fertilizer Company, South Hadley Falls, Mass.,	South Hadley Falls.
267	Oats, Buckwheat and Seeding-down,	Great Eastern Fertilizer Company, Rutland, Vt.,	Orange.
270	Havana Tobacco Fertilizer,	Quinnipiac Fertilizer Company, Boston, Mass.,	Hatfield.
272	Fish and Potash,	Pacific Guano Company, Boston, Mass.,	Belchertown.
274	Pride of the Valley,	Kirley Fertilizer Company, South Hadley Falls, Mass.,	Amherst.
	Bones.		
33	Pure Ground Bone,	C. A. Bartlett, Worcester, Mass.,	Worcester.
34	Pure Fine-ground Bone,	J. G. Jefferds, Worcester, Mass.,	Worcester.
125	Pure Ground Bone,	C. A. Bartlett, Worcester, Mass.,	Boston.
196	Pure Fine-ground Bone,	J. G Jefferds, Worcester, Mass.,	Hudson.
199	Bone Meal,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Fitchburg.
221	Ground Bone,	James E. McGovern, West Andover, Mass.,	Lawrence.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	NAME OF BRAND.	Moisture.	NITROGEN IN ONE HUNDRED POUNDS.		PHOSPHORIC ACID IN ONE HUNDRED POUNDS.							POTASSIUM OXIDE IN ONE HUNDRED POUNDS.	
								TOTAL.		AVAILABLE.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
168	Potash and Root Crop Manure, ...	7.88	4.35	4.12—4.94	5.07	3.38	1.43	9.88	7—9	8.45	5—6	7.45	7—9*
169	Excelsior Tobacco Grower, ...	9.35	4.10	3—4	6.70	2.18	3.07	11.95	8—11	8.88	8—11	5.64	5—6*
173	Fish and Potash, "Plain Brand," . . .	17.83	2.50	2.06—2.88	3.89	1.44	.61	5.94	6—9	5.33	4—6	4.04	4—6
175	Ground Bone and Potash, ...	4.23	1.27	-	.33	9.99	4.82	14.14	-	10.32	-	12.48	-
177	Dry Ground Fish, ...	13.92	7.70	8—10	1.36	3.22	2.56	7.14	7—8	4.58	-	-	-
184	Potato, Onion and Tobacco Grower, . . .	9.62	3.62	3.71—4.12	2.71	6.19	1.28	10.18	8—11	8.90	7—9	7.44	7—9
185	Fish and Potash, "Americus Brand," . .	16.68	2.35	2.06—2.88	4.09	2.82	1.07	7.98	6—9	6.91	4—6	2.48	4—6
194 237	West Andover Market Bone Phosphate, . .	12.58	1.56	2—3	4.02	9.62	.36	14.02	13—15	13.64	-	1.96	3—4
195	Tobacco and Sulphur, ...	13.08	2.20	1.96	-	-	-	.87	.75	-	-	7.67	7.66
205	King Philip Guano, ...	16.67	1.16	.91—1.65	5.94	3.53	.92	10.39	9—12	9.47	8—10	2.21	2—3
218	Tankage and Bone, ...	4.26	2.84	-	-	-	-	24.38	-	-	-	-	-
222	Royal Bone Phosphate, ...	17.38	1.45	1—1.64	3.89	6.09	1.15	11,13	8—12	9.98	7—10	2.66	2—3
228	Eclipse Phosphate, ...	13.93	1.20	1—2	4.71	4.50	2.30	11.51	10—14	9.21	8—11	1.82	1.5—2.5

<table>
<tr><td>230</td><td>Lawrence Fertilizer,</td><td>13.54</td><td>1.62</td><td>2.06—2.88</td><td>2.81</td><td>6.24</td><td>2.23</td><td>11.28</td><td>10—12</td><td>9.05</td><td>-</td><td colspan="2">2.10</td><td colspan="2">2—3</td></tr>
<tr><td>234</td><td>Potato and Tobacco Fertilizer,</td><td>11.60</td><td>1.92</td><td>2.06—2.80</td><td>2.56</td><td>6.90</td><td>1.54</td><td>11.00</td><td>9—14</td><td>9.46</td><td>8—11</td><td colspan="2">2.94</td><td colspan="2">3—4*</td></tr>
<tr><td>235</td><td>Soluble Pacific Guano,</td><td>13.06</td><td>2.06</td><td>2.25—3.00</td><td>6.88</td><td>2.70</td><td>.82</td><td>10.44</td><td>10.50—16</td><td>9.58</td><td>8.50—11</td><td colspan="2">2.23</td><td colspan="2">2—3.50</td></tr>
<tr><td>241</td><td>Potato, Onion and Tobacco Fertilizer,</td><td>14.42</td><td>3.39</td><td>3.25—4.25</td><td>4.76</td><td>3.66</td><td>1.07</td><td>9.49</td><td>8—9</td><td>8.42</td><td>6—8</td><td colspan="2">6.17</td><td colspan="2">6—7</td></tr>
<tr><td>246</td><td>Potato and Tobacco Manure,</td><td>12.51</td><td>2.94</td><td>2.06—2.88</td><td>4.20</td><td>5.21</td><td>2.00</td><td>11.41</td><td>9—13</td><td>9.41</td><td>8—11</td><td colspan="2">3.08</td><td colspan="2">3—4*</td></tr>
<tr><td>247
274</td><td>Pride of the Valley,</td><td>13.81</td><td>1.54</td><td>2.06—2.88</td><td>.82</td><td>6.34</td><td>.49</td><td>7.65</td><td>7—9</td><td>7.16</td><td>-</td><td colspan="2">3.16</td><td colspan="2">2.70—3.78*</td></tr>
<tr><td>267</td><td>Oats, Buckwheat and Seeding-down,</td><td>13.79</td><td>1.14</td><td>.82—1.65</td><td>.77</td><td>7.39</td><td>.90</td><td>9.06</td><td>9—15</td><td>8.16</td><td>8—12</td><td colspan="2">5.04</td><td colspan="2">4—6</td></tr>
<tr><td>270</td><td>Havana Tobacco Fertilizer,</td><td>10.15</td><td>6.38</td><td>5.77—6.59</td><td>1.38</td><td>1.59</td><td>.97</td><td>3.94</td><td>6—9</td><td>2.97</td><td>5—7</td><td colspan="2">10.88</td><td colspan="2">10—12</td></tr>
<tr><td>272</td><td>Fish and Potash,</td><td>18.67</td><td>3.48</td><td>2.06—2.88</td><td>3.04</td><td>2.82</td><td>.69</td><td>6.55</td><td>6—10</td><td>5.86</td><td>4—7</td><td colspan="2">3.77</td><td colspan="2">4—6</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">MECHANICAL ANALYSIS.</td></tr>
<tr><td></td><td><i>Bones.</i></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Fine.</td><td>Med. Fine.</td><td>Med.</td><td>Coarse Med.</td></tr>
<tr><td>33
125</td><td>Pure Ground Bone,</td><td>4.12</td><td>2.85</td><td>2—3</td><td>.49</td><td>18.88</td><td>7.80</td><td>27.17</td><td>27—29</td><td>19.37</td><td>-</td><td>57.08</td><td>28.60</td><td>13.77</td><td>.54</td></tr>
<tr><td>34
196</td><td>Pure Fine-ground Bone,</td><td>3.04</td><td>1.36</td><td>2.47—4.12</td><td>-</td><td>25.84</td><td>3.17</td><td>29.01</td><td>25—30</td><td>25.84</td><td>-</td><td>75.06</td><td>22.94</td><td>2.00</td><td>-</td></tr>
<tr><td>199</td><td>Bone Meal,</td><td>6.25</td><td>3.30</td><td>2—3</td><td>.03</td><td>16.29</td><td>7.60</td><td>23.92</td><td>25—28</td><td>16.32</td><td>-</td><td>38.35</td><td>29.25</td><td>21.92</td><td>10.48</td></tr>
<tr><td>221</td><td>Ground Bone,</td><td>8.87</td><td>1.80</td><td>-</td><td>.03</td><td>16.61</td><td>2.94</td><td>19.58</td><td>-</td><td>16.64</td><td>-</td><td>51.88</td><td>18.94</td><td>12.80</td><td>16.38</td></tr>
</table>

* Sulphate of potash, the source of potash.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
4	Tobacco Special,	Walker, Stratman & Co., Pittsburg, Pa.,	Amherst.
5	Four Fold,	Walker, Stratman & Co., Pittsburg, Pa.,	Amherst.
11	Grass and Oats Fertilizer,	M. E. Wheeler & Co., Rutland, Vt.,	Amherst.
16	Pulverized Bone and Meat,	Quinnipiac Fertilizer Company, Boston, Mass.,	Sunderland.
26	Animal Fertilizer,	J. G. Jefferds, Worcester, Mass.,	Worcester.
64	Dry Ground Fish Guano,	National Fertilizer Company, Bridgeport, Conn.,	Hadley.
88	Vegetator,	Davidge Fertilizer Company, New York, N. Y.,	Monson.
91	Nitrogenous Superphosphate,	John C. Dow & Co., Boston, Mass.,	Amherst.
101	Harvest Home Phosphate,	H. J. Baker & Bro., New York, N. Y.,	Fall River.
126	Strawberry Fertilizer,	Ames Fertilizer Company, Peabody, Mass.,	Dighton.
130	Nitrogenous Superphosphate,	John C. Dow & Co., Boston, Mass.,	Dighton.
132	Manhaden Fish Guano,	W. J. Brightman & Co., Tiverton, R. I.,	Dighton.
134	Potato Manure,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Dighton.
135	Economical Manure,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Dighton.
136	Church's B Special Fertilizer,	Daniel T. Church & Co., Providence, R. I.,	Dighton.
154	Sheep Fertilizer,	Wm. Elliott & Sons, New York, N. Y.,	Pittsfield.
162	Wheat and Corn Fertilizer,	Davidge Fertilizer Company, New York, N. Y.,	Westfield.

163	Ammoniated Wheat and Corn Phosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	North Adams.
183	Ammoniated Wheat and Corn Phosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Greenfield.
188	Sure Crop Phosphate,	Bowker Fertilizer Company, Boston, Mass.,	Shelburne Falls.
192	Grass Manure,	Williams & Clark Fertilizer Company, Boston, Mass.,	Greenfield.
193	Grass Fertilizer,	Quinnipiac Fertilizer Company, Boston, Mass.,	Williamstown.
200	Superphosphate,	William Lavery, Amesbury, Mass.,	Amesbury.
203	Gold Brand Excelsior Guano,	E. Frank Coe, New York, N. Y.,	Framingham.
204	Potato Fertilizer,	Cumberland Bone Phosphate Company, Boston, Mass.,	Hudson.
209	Great Planet "A,"	Clark Cove Fertilizer Company, Boston, Mass.,	Hudson.
219	Superphosphate,	William Lavery, Amesbury, Mass.,	Amesbury.
227	Potato Fertilizer,	Cumberland Bone Phosphate Company, Boston, Mass.,	Lowell.
252	Four Fold,	Walker, Stratman & Co., Pittsburg, Pa.,	Leeds.
257	Great Planet "A,"	Clark Cove Fertilizer Company, Boston, Mass.,	Westfield.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	NAME OF BRAND.	Moisture.	NITROGEN IN ONE HUNDRED POUNDS.		PHOSPHORIC ACID IN ONE HUNDRED POUNDS.							POTASSIUM OXIDE IN ONE HUNDRED POUNDS.	
								TOTAL.		AVAILABLE.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
4	Tobacco Special,	8.79	2.37	2.47—3.30	6.75	3.23	.97	10.95	10—12	9.98	8—10	4.00	3.24—4.32*
5 252	Four Fold,	9.95	1.80	1.65—2.47	5.99	3.68	1.64	11.31	10—11	9.67	8—9	1.66	2—3*
11	Grass and Oats Fertilizer,	15.42	-	-	6.26	3.18	.16	9.60	12—18	9.44	10—14	2.33	2—4*
16	Pulverized Bone and Meat,	6.17	5.60	4.94—5.77	.26	7.72	9.98	17.96	18—20	7.98	-	-	-
26	Animal Fertilizer,	10.51	2.50	2.47—3.30	4.76	6.21	6.35	17.32	16—18	10.97	11—13	2.58	2.5—3.5
64	Dry Ground Fish Guano,	9.64	7.41	-	.64	5.70	.72	7.06	-	6.34	-	-	-
88	Vegetator,	12.37	2.10	2.06—3.71	9.22	1.86	1.28	12.36	-	11.08	5—7	1.92	3—5
91 130	Nitrogenous Superphosphate,	16.10	2.10	2.06—2.88	2.97	7.63	1.94	12.54	8—10	10.60	-	4.37	1.89—2.53
101	Harvest Home Phosphate,	12.21	1.46	1.03—1.65	1.64	7.63	1.07	10.34	-	9.27	8—10	3.36	2—2.5
126	Strawberry Fertilizer,	13.00	2.70	2.47—3.30	4.73	3.97	3.15	11.85	10—12	8.70	9—11	6.42	6—7
132	Manhaden Fish Guano,	9.81	8.20	8.24—9.89	1.05	3.54	2.46	7.05	6.87—9.16	4.59	-	-	-
134	Potato Manure,	6.23	3.80	3.71—4.12	2.12	3.74	2.38	8.24	8—10	5.86	8	3.36	6—8*

135	Economical Manure, ...	11.42	2.78	2.47—3.30	4.25	3.93	.31	8.49	8—10	8.18	6—8	9.86	8—10
136	Church's B Special Fertilizer, ...	11.48	3.40	3.73—4.52	1.84	6.30	2.71	10.85	9—13	8.14	8—11	6.16	6—7
154	Sheep Fertilizer, ...	9.40	1.91	-	-	-	-	2.18	-	-	-	3.02	-
162	Wheat and Corn Fertilizer, ...	11.52	1.01	.82—1.65	10.50	2.34	1.66	14.50	8—12	12.84	7—9	1.24	1—2
163 183	Ammoniated Wheat and Corn Phosphate, .	12.64	2.26	2—3	6.70	3.54	1.79	12.03	-	10.24	10—13	1.35	1.60—2.70
188	Sure Crop Phosphate, ...	11.75	.90	.75—1.50	4.35	4.96	3.28	12.59	-	9.31	8—10	1.17	1—2
192	Grass Manure, ...	11.23	3.44	3.91—4.74	2.25	3.43	1.07	6.75	6—8	5.68	5—7	2.39	2—3
193	Grass Fertilizer, ...	10.36	3.10	3.91—4.74	2.48	4.12	1.18	7.78	6—8	6.60	5—7	2.33	2—3
200 219	Superphosphate, ...	16.10	1.75	1.97	1.07	6.70	.72	8.49	-	7.77	10.17	1.28	2.36
203	Gold Brand Excelsior Guano, ...	7.70	2.60	2.5—3	6.70	2.41	1.94	11.05	9—13	9.11	8—11	6.25	6—8
204 227	Potato Fertilizer, ...	15.52	1.91	2.06—2.88	6.04	3.25	1.30	10.59	11—13	9.29	9—11	3.40	3—4
209 257	Great Planet " A,"	10.44	3.16	3.30—4.12	2.56	7.06	2.35	11.97	9—13.50	9.62	8—11.50	7.21	7—8

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* Sulphate of potash, the source of potash.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at —
	Compound Fertilizers.		
210	New Rival Ammoniated Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Newburyport.
213	New Method Fertilizer,	Bradley Fertilizer Company, Boston, Mass.,	Lowell.
217	Lawn Fertilizer,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Fitchburg.
223	New Method Fertilizer,	Bradley Fertilizer Company, Boston, Mass.,	Amesbury.
236	Prolific Crop Producer,	Williams & Clark Fertilizer Company, Boston, Mass.,	Lowell.
248	Standard Superphosphate,	Standard Fertilizer Company, Boston, Mass.,	Ludlow.
251	Corn Manure,	H. J. Baker & Bro., New York, N. Y.,	East Longmeadow.
253	Ammoniated Bone Superphosphate,	Leander Wilcox, Mystic, Conn.,	South Hadley Falls.
259	Bay State G G,	Clark Cove Fertilizer Company, Boston, Mass.,	East Longmeadow.
260	Corn Manure,	H. J. Baker & Bro., New York, N. Y.,	Northampton.
262	Dry Ground Fish Guano,	Leander Wilcox, Mystic, Conn.,	Amherst.
264	Connecticut Wrapper Fertilizer,	Cleveland Linseed Oil Company, Cleveland, Ohio,	Amherst.
265	Coarse Linseed Meal,	Cleveland Linseed Oil Company, Cleveland, Ohio,	South Deerfield.
268	Onion Manure,	Quinnipiac Fertilizer Company, Boston, Mass.,	Hatfield.
269	Corn and Grain Phosphate,	Cleveland Dryer Company, Boston, Mass.,	Monson.
271	Lawn and Garden Fertilizer,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Worcester.
273	High-grade General Fertilizer,	Pacific Guano Company, Boston, Mass.,	Belchertown.

	Chemicals.		
24	Nitrate of Soda,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
25	Nitrate of Soda,	Quinnipiac Fertilizer Company, Boston, Mass.,	Sunderland.
50	Sulphate of Potash and Magnesia,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
59	Sulphate of Potash and Magnesia,	Williams & Clark Fertilizer Company, Boston, Mass.,	Sunderland.
	Bones.		
207	Pure Ground Bone,	Wm. Lavery, Amesbury, Mass.,	Amherst.
231	Pure Ground Bone,	Wm. Lavery, Amesbury, Mass.,	Amesbury.
240	Ground Bone,	Bryant & Brett, New Bedford, Mass.,	Amherst.
256	Ground Bone,	H. J. Baker & Bro., New York, N. Y.,	East Longmeadow.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	NAME OF BRAND.	Moisture.	NITROGEN IN ONE HUNDRED POUNDS.		PHOSPHORIC ACID IN ONE HUNDRED POUNDS.							POTASSIUM OXIDE IN ONE HUNDRED POUNDS.	
								TOTAL.		AVAILABLE.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
210	New Rival Ammoniated Superphosphate,	11.25	1.26	1.20—2.00	5.01	3.69	1.79	10.49	11—14	8.70	10—12	2.32	1.60 3.00
213 223	New Method Fertilizer,	12.83	1.33	.82—1.65	5.12	3.53	1.43	10.08	10—12	8.65	8—10	2.20	2.16—3.24
217	Lawn Fertilizer,	3.75	2.49	3.29—4.00	-	8.92	17.92	26.84	19—22	8.92	-	1.30	3.25—4.30
236	Prolific Crop Producer,	12.97	1.19	.82—1.65	4.86	3.70	2.18	10.74	7—11	8.56	6—9	2.17	1—2
248	Standard Superphosphate,	11.78	2.48	2.5—3.5	4.09	5.32	2.10	11.51	11—16	9.41	9—13	2.00	2—3
251 260	Corn Manure,	7.54	4.19	4.12	2.92	4.04	1.74	8.70	-	6.96	6.25	7.50	7
253	Ammoniated Bone Superphosphate,	15.70	2.88	2.50—3.50	3.96	2.68	1.80	8.44	7—8	6.64	6—7	6.02	5—6
259	Bay State "G G,"	12.32	2.41	1.85—2.68	6.02	3.06	3.46	12.54	10—13	9.08	8.50—11	1.88	2—3
262	Dry Ground Fish Guano,	8.85	8.60	8—10	.52	4.40	2.82	7.74	6—8	4.92	4—6	-	-
264	Connecticut Wrapper Fertilizer,	5.90	4.16	4.5—5.25	.52	4.46	2.56	7.54	5.70—6.20	4.98	-	13.18	10—11
265	Coarse Linseed Meal,	9.27	6.54	5.90—6.00	-	-	-	2.10	2	-	-	1.71	1.40—1.50
268	Onion Manure,	10.12	3.38	3.30—4.12	2.44	4.93	3.58	11.00	9—13	7.42	8—11	7.66	7—8*

<table>
<tr><td>269</td><td>Corn and Grain Phosphate,</td><td>15.88</td><td>1.97</td><td>2.02—2.88</td><td>5.17</td><td>4.60</td><td>.72</td><td>10.49</td><td>10 50—14.50</td><td>9.77</td><td>9.50—12 50</td><td colspan="2">2 44</td><td colspan="2">1.50—2 50</td></tr>
<tr><td>271</td><td>Lawn and Garden Fertilizer,</td><td>10.27</td><td>3.58</td><td>4.94—6.59</td><td>4.78</td><td>2.20</td><td>3 38</td><td>10.36</td><td>10—12</td><td>6.98</td><td>-</td><td colspan="2">5.77</td><td colspan="2">5—6</td></tr>
<tr><td>273</td><td>High-grade General Fertilizer,</td><td>11.18</td><td>3.64</td><td>2.68—3.50</td><td>3.33</td><td>4.04</td><td>2.30</td><td>9.67</td><td>9—13</td><td>7.37</td><td>8—11</td><td colspan="2">6.36</td><td colspan="2">7—8*</td></tr>
<tr><td></td><td><i>Chemicals.</i></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>24</td><td>Nitrate of Soda,</td><td>.76</td><td>15.68</td><td>15.66—16.48</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td colspan="2">-</td><td colspan="2">-</td></tr>
<tr><td>25</td><td>Nitrate of Soda,</td><td>.97</td><td>16.04</td><td>15.66—16.48</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td colspan="2">-</td><td colspan="2">-</td></tr>
<tr><td>50</td><td>Sulphate of Potash and Magnesia,</td><td>2.01</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td colspan="2">25.08</td><td colspan="2">25.94—28.10</td></tr>
<tr><td>59</td><td>Sulphate of Potash and Magnesia,</td><td>4.31</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td colspan="2">28.63</td><td colspan="2">25.94—28.10</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">MECHANICAL ANALYSIS.</td></tr>
<tr><td></td><td><i>Bones.</i></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Fine.</td><td>Med. Fine.</td><td>Med.</td><td>Coarse Med.</td></tr>
<tr><td>207
231</td><td>Pure Ground Bone,</td><td>11.92</td><td>3.42</td><td>-</td><td>-</td><td>3.96</td><td>5.38</td><td>9.34</td><td>-</td><td>3.96</td><td>-</td><td>32.54</td><td>24.05</td><td>36.81</td><td>6 60</td></tr>
<tr><td>240</td><td>Ground Bone,</td><td>3.92</td><td>2.90</td><td>2.50</td><td>.38</td><td>7.45</td><td>18.54</td><td>26.37</td><td>25.56</td><td>7.83</td><td>-</td><td>26.53</td><td>26.80</td><td>31.77</td><td>14.90</td></tr>
<tr><td>256</td><td>Ground Bone,</td><td>7.27</td><td>4.36</td><td>3.30—3.71</td><td>.67</td><td>8.64</td><td>11.64</td><td>20.95</td><td>22—25</td><td>9.31</td><td>-</td><td>38.58</td><td>44.28</td><td>17.14</td><td>-</td></tr>
</table>

* Sulphate of potash, the source of potash.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at —
	Chemicals.		
13	Muriate of Potash,	Quinnipiac Fertilizer Company, Boston, Mass.,	Sunderland.
23	Muriate of Potash,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
44	Dried Blood,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
48	Muriate of Potash,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
49	Sulphate of Potash, "High Grade,"	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
52	Sulphate of Ammonia,	Quinnipiac Fertilizer Company, Boston, Mass.,	Sunderland.
54	Sulphate of Ammonia,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
57	Nitrate of Soda,	Williams & Clark Fertilizer Company, Boston, Mass.,	Sunderland.
72	Sulphate of Potash, "High Grade,"	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
75	Muriate of Potash,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
118	Muriate of Potash,	Bradley Fertilizer Company, Boston, Mass.,	Boston.
128	Nitrate of Soda,	Bradley Fertilizer Company, Boston, Mass.,	Boston.
153	Muriate of Potash,	H. J. Baker & Bro., New York, N. Y.,	South Deerfield.
191	Nitrate of Soda,	H. J. Baker & Bro., New York, N. Y.,	South Deerfield.
216	Sulphate of Ammonia,	Bradley Fertilizer Company, Boston, Mass.,	Amesbury.
224	Nitrate of Soda,	Williams & Clark Fertilizer Company, Boston, Mass.,	Hadley.
225	Nitrate of Soda,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
232	Nitrate of Soda,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Haverhill.
249	Muriate of Potash,	Leander Wilcox, Mystic, Conn.,	South Hadley Falls.
254	Nitrate of Soda,	Clark Cove Fertilizer Company, Boston, Mass.,	East Longmeadow.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Concluded.*

Laboratory Number.	NAME OF BRAND.	Moisture.	NITROGEN.		POTASSIUM OXIDE.	
			Found.	Guaranteed.	Found.	Guaranteed.
	Chemicals.					
13	Muriate of Potash,	1.03	-	-	51.08	50.54—53.70
23	Muriate of Potash,	1.37	-	-	50.52	50.54—53.70
44	Dried Blood,	5.56	9.70	9.89—11.53	-	-
48	Muriate of Potash,	.75	-	-	52.20	50.54—53.70
49	Sulphate of Potash, "High Grade,"	.33	-	-	50.80	48.64—51.34
52	Sulphate of Ammonia,	.33	20.81	20.60—21.42	-	-
54	Sulphate of Ammonia,	2.20	19.79	19.78—20.60	-	-
57 224	Nitrate of Soda,	1.27	15.87	15.48—15.81	-	-
72	Sulphate of Potash, "High Grade,"	.47	-	-	49.56	48.63—51.83
75	Muriate of Potash,	.14	-	-	52.36	50.54—53.70
118	Muriate of Potash,	.96	-	-	51.48	50.54—53-70
128	Nitrate of Soda,	1.58	16.22	14.83—16.48	-	-
153	Muriate of Potash,	.53	-	-	48.24	50.54—53.70
191	Nitrate of Soda,	1.26	15.32	14.82—15.64	-	-
216	Sulphate of Ammonia,	.25	20.84	20.60—21.42	-	-
225	Nitrate of Soda,	2.35	15.48	15.48—15.81	-	-
232	Nitrate of Soda,	1.27	16.02	-	-	-
249	Muriate of Potash,	2.65	-	-	51.72	50.54—53.70
254	Nitrate of Soda,	1.35	15.45	15.66	-	-

5. ANALYSES OF COMMERCIAL FERTILIZERS AND MANURIAL SUBSTANCES SENT ON FOR EXAMINATION.

Wood Ashes.

[I., II. and III., sent on from Concord, Mass.; IV. and V., sent on from Lowell, Mass.; VI., sent on from Amherst, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI
Moisture at 100° C.,	6.75	15.38	6.05	23.00	19.10	7.97
Calcium oxide,	42.72	43.00	–	33.88	30.32	18.70
Phosphoric acid,	1.66	1.10	1.43	1.02	1.02	2.04
Potassium oxide,	6.02	5.23	6.54	3.01	5.18	7.48
Insoluble matter,	7.71	8.84	9.74	10.88	13.38	22.03

Wood Ashes.

[I. and II., sent on from Concord, Mass.; III., sent on from Concord Junction, Mass.; IV., sent on from Amherst, Mass.; V., sent on from Rock Bottom, Mass.; VI., sent on from Walpole, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C.,	14.96	9.86	5.93	1.29	14.69	16.06
Calcium oxide,	29.52	32.74	40.48	32.26	–	–
Phosphoric acid,	1.79	1.48	1.77	4.04	1.28	1.33
Potassium oxide,	5.25	6.17	7.84	9.20	5.04	5.20
Insoluble matter,	13.18	18.96	7.21	11.22	12.29	14.31

Wood Ashes.

[I., sent on from North Andover, Mass.; II., sent on from Hudson, Mass.; III., sent on from Westborough, Mass.; IV., V. and VI., sent on from Concord, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C.,	19.11	.19	22.26	7.80	14.52	16.08
Calcium oxide,	38.20	36.70	30.24	33.00	36.50	32.61
Potassium oxide,	5.98	3.96	5.04	4.47	5.13	4.50
Phosphoric acid,	1.28	.90	1.15	1.13	1.68	1.22
Insoluble matter,	13.12	14.61	–*	10.28	11.03	13.70

* Not determined.

5. ANALYSES, ETC. — *Continued.*

Wood Ashes.

[I., sent on from Beverly, Mass.; II., sent on from Boston, Mass.; III. and IV., sent on from Concord, Mass.; V. and VI., sent on from Waltham, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI
Moisture at 100° C., .	6.44	2.52	11.61	4.88	.57	10.92
Calcium oxide, . .	-*	34.46	35.05	30.20	28.17	33.13
Potassium oxide, .	5.28	4.31	4.59	4.80	6.02	4.46
Phosphoric acid, . .	1.28	.67	.87	1.41	1.65	1.42
Insoluble matter, .	15.40	12.63	15.97	15.61	16.87	23.65

Wood Ashes.

[I. and II., sent on from Concord, Mass.; III., sent on from Granby, Mass.; IV., sent on from Lakeville, Mass.; V., sent on from Sunderland, Mass.; VI., sent on from Leverett, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C., .	9.67	11.13	20.51	6.45	12.59	16.69
Phosphoric acid, . .	1.43	1.43	1.36	.51	.82	1.59
Potassium oxide, .	7.32	5.22	5.62	5.96	7.54	5.98
Insoluble matter, .	8.94	23.13	17.08	-*	-*	-*

Wood Ashes.

[I., sent on from Concord, Mass.; II. and III., sent on from Beverly, Mass.; IV. and V., sent on from South Deerfield, Mass.; VI., sent on from South Sudbury, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C., .	12.32	10.17	2.05	2.33	13.65	33.23
Phosphoric acid, . .	1.42	1.61	1.79	1.54	1.46	.90
Potassium oxide, .	6.40	5.21	4.64	6.09	4.68	4.09
Insoluble matter, .	10.27	-*	-*	-*	-*	9.79

* Not determined.

5. ANALYSES, ETC. — *Continued.*

Wood Ashes.

[I. and II., sent on from Waltham, Mass.; III. and IV., sent on from Northfield, Mass.; V., sent on from Sunderland, Mass.; VI., sent on from South Hadley, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C., .	11.75	9.25	12.20	6.25	20.60	2.35
Phosphoric acid, . .	1.71	1.38	1.33	1.33	1.56	1.71
Potassium oxide, .	5.10	4.32	5.18	4.65	4.78	3.46
Insoluble matter, .	–*	23.78	17.16	24.44	–*	–*

Wood Ashes.

[I., sent on from South Sudbury, Mass.; II., sent on from South Framingham, Mass.; III., sent on from South Amherst, Mass.; IV., sent on from Concord, Mass.; V., sent on from North Hadley, Mass.; VI., sent on from West Northfield, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C., .	11.77	3.23	17.20	10.38	11.41	18.30
Phosphoric acid, . .	1.44	1.26	1.66	1.28	1.62	1.40
Potassium oxide, .	5.20	4.12	4.24	5.76	6.12	5.20
Insoluble matter, .	19.40	–*	13.05	–*	9.34	8.87

Wood Ashes.

[I. and II., sent on from Beverly, Mass.; III., sent on from Lawrence, Mass.; IV., sent on from Danvers, Mass.; V., sent on from Lunenburg, Mass.; VI., sent on from Arlington, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C., .	2.62	6.10	19.52	10.87	18.73	7.05
Phosphoric acid, . .	1.28	1.54	1.50	.56	1.02	1.36
Potassium oxide, .	4.73	5.84	6.04	6.32	8.71	5.81
Insoluble matter, .	–*	8.85	12.48	20.22	10.94	23.82

* Not determined.

5. ANALYSES, ETC. — *Continued.*

Wood Ashes.

[I., sent on from Bernardston, Mass.; II., sent on from Concord, Mass.; III., sent on from Amherst, Mass.; IV., sent on from Methuen, Mass.; V. and VI., sent on from Concord, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C.,	20.58	12.32	7.57	15.39	13.60	17.80
Phosphoric acid,	1.36	1.42	1.60	1.80	1.18	1.36
Potassium oxide,	3.68	6.40	8.50	4.60	5.39	5.75
Insoluble matter,	9.80	10.27	8.48	-*	17.48	10.36

Wood Ashes.

[All sent on from Concord, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C.,	15.22	21.36	19.48
Phosphoric acid,	1.07	–	.98
Potassium oxide,	5.07	1.20	6.08
Insoluble matter,	12.46	3.66	9.90

Cotton-hull Ashes.

[I., sent on from North Hadley, Mass.; II. and III., sent on from Hatfield, Mass.; IV., sent on from Sunderland, Mass.]

	PER CENT.			
	I.	II.	III.	IV.
Moisture at 100° C.,	8.72	9.45	11.00	7.89
Phosphoric acid,	9.40	9.96	6.84	5.46
Potassium oxide,	25.50	25.48	15.40	26.36
Insoluble matter,	6.08	-*	-*	-*

* Not determined.

5. ANALYSES, ETC. — *Continued.*

Lime-kiln Ashes.

[I., sent on from Sunderland, Mass.; II. and III., sent on from Amherst, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C.,	.68	24.09	15.01
Phosphoric acid,	1.48	1.57	.77
Potassium oxide,	5.20	1.57	.77
Calcium oxide,	–*	36.69	45.28
Insoluble matter,	–*	11.76	3.31

* Not determined.

Swill Ashes (from Cremation Furnace).

[Sent on from Amherst, Mass.]

	PER CENT.						
	I.	II.	III.	IV.	V.	VI.	VII.
Moisture at 100° C.,	2.43	19.46	12.48	.37	7.57	14.24	8.05
Potassium oxide,	1.59	1.78	3.35	4.27	3.96	5.09	4.92
Phosphoric acid,	25.89	5.22	6.50	12.97	13.92	6.86	13.22
Insoluble matter,	17.93	30.81	31.54	34.91	19.96	37.76	24.52

Lime and Ashes.

[Sent on from Boston, Mass.]

	Per Cent.
Moisture at 100° C.,	.65
Calcium oxide,	57.17
Potassium oxide,	.77
Phosphoric acid,	1.02
Insoluble matter,	13.86

Coal Ashes.

[Sent on from Framingham.]

	Per Cent.
Moisture at 100° C.,	32.37
Potassium oxide,	.42
Phosphoric acid,	.37
Nitrogen,	.33
Insoluble matter,	34.52

5. ANALYSES, ETC. — *Continued.*

Refuse Materials.

[I., refuse from calico works, sent on from Seekonk, Mass.; II., hair waste, sent on from Concord, Mass.; III. and IV., cotton waste, sent on from Concord, Mass.; V., wool waste, sent on from Lawrence, Mass.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	4.07	72.81	10.01	10.93	2.23
Phosphoric acid,	11.95	.61	.31	1.80	.38
Potassium oxide,	–	.32	1.20	1.51	3.50
Nitrogen,	4.28	1.79	3.43	9.33	.96

Muck.

[Sent on from North Wilbraham, Mass.; I., light colored; II., dark colored.]

	PER CENT.	
	I.	II.
Moisture at 100° C.,	53.06	80.42
Calcium oxide,	.73	.22
Potassium oxide,	.05	.06
Phosphoric acid,	.04	.05
Nitrogen,	.52	.44
Insoluble matter,	38.35	6.06

Muck.

[I., sent on from South Amherst, Mass.; II., sent on from Plymouth, Mass.; III., sent on from Miller's Falls, Mass.]

	PER CENT.		
	I	II.	III.
Moisture at 100° C.,	70.02	61.53	76.75
Ash,	11.54	30.05	4.38
Nitrogen,	.69	.43	.40

Soot.

[Sent on from South Lancaster, Mass.]

	Per Cent.
Moisture at 100° C.,	5.39
Potassium oxide,	.52
Phosphoric acid,	.90

5. ANALYSES, ETC. — *Continued.*

Residue from Water Filter.

[Sent on from East Walpole, Mass.]

	Per Cent
Moisture at 100° C.,	94.22
Phosphoric acid,	.05
Nitrogen,	.12

Vegetable Mould.

[Sent on from Springfield, Mass.]

	Per Cent.
Moisture at 100° C.,	77.64
Nitrogen,	.30

Soot.

[Sent on from Lynn, Mass.; I., black; II., brown.]

	PER CENT.	
	I.	II.
Moisture at 100° C.,	2.09	.13
Phosphoric acid,	.74	2.10
Potassium oxide,	.46	.59
Nitrogen,	1.05	-

Barnyard Manure.

[Sent on from Hatfield, Mass.]

	Per Cent.
Moisture at 100° C.,	72.080
Phosphoric acid,	.304
Potassium oxide,	.641
Nitrogen,	.541
Insoluble matter,	2.730

Goose Manure.

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	49.820
Phosphoric acid,	.957
Potassium oxide,	.810
Nitrogen,	.213

5. ANALYSES, ETC. — *Continued.*

Hen House Refuse.

[Sent on from Fitchburg, Mass.]

	Per Cent.
Moisture at 100° C.,	3.43
Phosphoric acid,	1.28
Potassium oxide,	.60
Nitrogen,	.98

Waste Lime.

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	.80
Calcium oxide,	74.12
Insoluble matter,	.38

Potash Magnesia Sulphate.

[Sent on from Hatfield, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C.,	5.34	4.73	1.19
Potassium oxide,	26.80	26.32	27.28

Muriate of Potash.

[I. and II., sent on from Sunderland, Mass.; III., sent on from Leverett, Mass.; IV., sent on from Hudson, Mass.]

	PER CENT.			
	I.	II.	III.	IV.
Moisture at 100° C.,	.91	.13	1.20	1.05
Potassium oxide,	52.50	49.00	52.60	51.16

5. Analyses, etc. — *Continued.*

Florida Phosphate.

[I., soft variety, sent on from Boston, Mass.; II., sent on from Brookline, Mass.; III., sent on from South Hadley Falls, Mass.; IV., soft variety, sent on from South Chelmsford, Mass.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	3.35	1.20	3.69	9.03
Calcium oxide,	30.22	32.80	–*	–*
Phosphoric acid,	19.94	24.49	20.79	18.54
Ferric and aluminic oxides,	9.96	6.93	–*	–*
Potassium oxide,	.29	–	–	–
Insoluble matter,	30.86	23.91	25.48	26.55

* Not determined.

Tankage.

[I., II., III , IV. and V., sent on from Boston, Mass.; VI., sent on from Concord, Mass.]

	Per Cent.					
	I.	II.	III	IV.	V.	VI.
Moisture at 100° C.,	9.24	9.23	14.95	9.01	6.27	10.33
Phosphoric acid,	10.84	12.28	10.23	12.60	11.23	4.03
Nitrogen,	6.94	8.27	8.72	8.26	7.51	9.16

Fish Waste.

[I , II. and III., sent on from Gloucester, Mass.; IV. and V., sent on from Boston, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	10.37	6.17	6.86	20.71	11.95
Phosphoric acid,	8.96	5.38	11.90	15.91	13.93
Nitrogen,	10.80	11.08	9.12	5.97	7.69

5. Analyses, etc. — *Continued.*

Ground Bone.

[I., sent on from West Berlin, Mass.; II., III., IV. and V., sent on from Lincoln, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	4.97	3.76	4.31	4.01	3.64
Total phosphoric acid,	15.81	28.78	28.66	25.64	20.98
Available phosphoric acid,	15.71	-	-	-	-
Insoluble phosphoric acid,	.10	-	-	-	-
Nitrogen,	2.82	3.50	3.54	4.21	3.23

Ground Bone.

[I., sent on from Salisbury, Mass.; II., sent on from Townsend Harbor, Mass.; III., sent on from West Newbury, Mass.; IV., dissolved bone, sent on from Lancaster, Mass.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	34.55	5.84	3.95	8.79
Total phosphoric acid,	11.42	27.90	26.55	14.12
Available phosphoric acid,	-*	26.51	21.75	13.61
Insoluble phosphoric acid,	-*	1.39	4.80	.51
Nitrogen,	4.04	2.87	2.09	.59
Mechanical Analysis.				
Fine bone,	-*	39.27	58.35	-*
Fine medium bone,	-*	32.43	25.95	-*
Medium bone,	-*	25.00	15.70	-*
Coarse medium bone,	-*	3.30	-	-*
	-	100.00	100.00	-

* Not determined.

Cotton-seed Meal.

[I. and II., sent on from Hatfield, Mass.; III., sent on from Hadley, Mass. (damaged); IV., sent on from Amherst, Mass.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C,	8.75	8.23	12.57	9.01
Total phosphoric acid,	2.12	3.08	2.48	2.11
Potassium oxide,	1.51	1.94	1.66	2.38
Nitrogen,	7.70	7.17	5.68	7.11

5. ANALYSES, ETC. — *Concluded.*

Commercial Fertilizers (Complete).

[I. and II., sent on from Granby, Mass.; III., sent on from Dighton, Mass.; IV., sent on from Concord, Mass.; V., sent on from Hatfield, Mass.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	12.81	12.46	8.29	19.76	6.20
Total phosphoric acid,	10.62	9.39	11.85	10.59	2.89
Soluble phosphoric acid,	.26	5.99	6.12	1.97	–
Reverted phosphoric acid,	10.01	2.43	4.61	7.01	1.56*
Insoluble phosphoric acid,	.35	.97	1.13	1.64	1.33
Potassium oxide,	2.78	10.03	10.11	3.78	11.26
Nitrogen,	2.28	3.55	3.69	3.13	4.05

* Available.

Commercial Fertilizers (Complete).

[I., sent on from Hatfield, Mass.; II., sent on from Pittsfield, Mass.; III, sent on from Lancaster, Mass.; IV., sent on from Hatfield, Mass.; V., sent on from East Lexington, Mass.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	5.61	11.07	10.39	6.54	5.36
Total phosphoric acid,	6.75	11.82	10.64	12.62	8.37
Available phosphoric acid,	–*	11.31	8.77	–*	6.91
Insoluble phosphoric acid,	–*	.51	1.87	–*	1.46
Potassium oxide,	9.12	5.26	5.86	11.82	9.44
Nitrogen,	2.60	3.02	2.29	5.42	2.90

* Not determined.

Commercial Fertilizers (Complete).

[I., sent on from East Lexington, Mass.; II., III., IV. and V., sent on from Eastham, Mass.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	5.63	.76	19.76	15.21	9.17
Total phosphoric acid,	5.94	27.12	2.82	.64	14.96
Available phosphoric acid,	4.35	1.40	2.30	.64	14.70
Insoluble phosphoric acid,	1.59	25.72	.52	–	.26
Potassium oxide,	6.08	1.48	9.00	9.32	1.51
Nitrogen,	2.16	.06	1.35	2.18	.09

6. MISCELLANEOUS ANALYSES.

Cooking Soda.

[Sent on from South Acton, Mass.]

	Per Cent.
Total carbonic acid,	48.25
Available carbonic acid,	15.25
Sulphuric acid,	.31
Hydrochloric acid,	.23
Insoluble matter,	Trace.

Baking Powder.

[Sent on from North Amherst, Mass.]

	Per Cent.
Available carbonic acid,	8.40
Aluminic oxide,	3.49
Phosphoric acid,	4.76
Ammonia,	.75
Sulphuric acid,	5.41
Calcium oxide,	6.08

Soil Deposit.

[Sent on from Shirley, Mass.]

	Per Cent.
Moisture at 100° C.,	6.13
Calcium oxide,	.38
Ferric and aluminic oxides,	.79
Potassium oxide,	.18
Phosphoric acid,	.04
Insoluble matter,	83.18

Soil.

[Sent on from Gardner, Mass.]

	Per Cent.
Moisture at 100° C.,	8.33
Calcium oxide,	.44
Ferric and aluminic oxides,	1.20
Potassium oxide,	.18
Phosphoric acid,	.14
Nitrogen,	.87
Insoluble matter,	58.49

7. MISCELLANEOUS FODDER ANALYSES.

A. Analyses of Food Articles (Human Food).

Quaker Self-raising Buckwheat Flour.

[Sent on from Ravenna, O.]

	Per Cent.
Moisture at 100° C.,	13.36
Dry matter,	86.64
	100.00

Analysis of Dry Matter.

Crude ash,	5.21
" fibre,	.42
" fat,	.90
" protein,	6.35
Nitrogen-free extract matter,	87.12
	100.00

Hecker's Hominy.

[Sent on from New York, N. Y.]

	Per Cent.
Moisture at 100 C.,	9.56
Dry matter,	90.44
	100.00

Analysis of Dry Matter.

Crude ash,	.22
" fibre,	.45
" fat,	.83
" protein,	9.02
Nitrogen-free extract matter,	89.48
	100.00

Macaroni (Royal Egg Brand).

[Sent on from Minneapolis, Minn.]

	Per Cent.
Moisture at 100° C.,	9.07
Dry matter,	90.93
	100.00

Analysis of Dry Matter.

Crude ash,	–
" fibre,	.34
" fat,	.57
" protein,	12.88
Nitrogen-free extract matter,	86.21
	100.00

Farina (a Wheat Product).

[Sent on from Wilmington, Del.]

	Per Cent.
Moisture at 100° C.,	10.65
Dry matter,	89.35
	100.00

7. MISCELLANEOUS FODDER ANALYSES — *Continued.*

Analysis of Dry Matter.

	Per Cent.
Crude ash,	.06
" fibre,	.74
" fat,	1.98
" protein,	11.62
Nitrogen-free extract matter,	85.60
	100.00

Condensed Milk.

[No. 1, Milkmaid Brand; No. 2, Eagle Brand.]

	PER CENT.	
	No. 1.	No. 2.
Moisture at 100° C.,	24.48	26.38
Total solids,	75.52	73.62
Fat,	8.95	7.01
Cosein,	9.31	–*
Milk sugar,	13.04	10.04
Cane sugar,	37.43	42.46

Gelatine.

[Sent on from Johnstown, N. Y.]

	PER CENT.			
	No. 1.	No. 2.	No. 3.	Rose-colored.
Moisture at 100° C.,	15.39	15.36	13.94	14.09
Nitrogen,	14.28	14.28	14.68	14.40
Ash,	1.40	1.48	1.88	1.74

*Thacher's Sugar of Milk Baking Powder.**

	Per Cent.
Available carbonic acid,	13.96
Milk sugar,	3.80

Peanut Meal.

[Sent on from Washington, D. C.]

	Per Cent.
Moisture at 100° C.,	8.00
Dry matter,	92.00
	100.00

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* Completely soluble in water.

7. MISCELLANEOUS FODDER ANALYSES — *Continued.*

Analysis of Dry Matter.

	Per Cent.
Crude ash,	4.29
" fibre,	3.76
" fat,	11.69
" protein,	53.26
Nitrogen-free extract matter,	27.00
	100.00

Fertilizing Constituents.

Moisture at 100° C.,	8.00
Potassium oxide,	1.27
Phosphoric acid,	1.54
Nitrogen,	7.84

B. Analyses of Fodder Articles.

The names of the articles described below are those given by the parties sending them for analysis. As the food value of concentrated feed stuffs depends materially on the amount of crude protein and crude fat present, the analysis has been confined in several instances to the determination of these two constituents.

[I., cotton-seed meal, sent on from North Amherst, Mass.; II., cotton-seed meal, sent on from Hatfield, Mass.]

	PER CENT.	
	I.	II.
Moisture at 100° C.,	8.99	9.45
Dry matter,	91.01	90.55
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	7.10	–*
" fibre,	5.53	–*
" fat,	9.66	11.20
" protein,	50.34	40.92
Nitrogen-free extract matter,	27.37	–*
	100.00	-
Fertilizing Constituents.		
Moisture at 100° C.,	8.99	9.45
Phosphoric acid,	–*	3.65
Potassium oxide,	–*	2.34
Nitrogen,	7.33	5.93

* Not determined.

7. MISCELLANEOUS FODDER ANALYSES — *Continued.*

[I., cotton-seed meal (undecorticated), sent on from Hatfield, Mass.; II., cotton-seed bran, sent on from New York, N. Y.]

	PER CENT.	
	I.	II.
Moisture at 100° C.,	10.77	10.10
Dry matter,	89.23	89.90
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	-*	3.58
" fibre,	-*	31.09
" fat,	5.41	3.17
" protein,	23.69	11.82
Nitrogen-free extract matter,	-*	50.34
	-	100.00
Fertilizing Constituents.		
Moisture at 100° C.,	10.77	10.10
Phosphoric acid,	2.04	-*
Potassium oxide,	2.18	-*
Nitrogen,	3.38	1.70

[I., Chicago gluten meal, sent on from Amherst, Mass.; II., Chicago gluten meal, sent on from Boston, Mass.; III., King gluten meal, from station barn]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C.,	9.33	10.22	7.18
Dry matter,	90.67	89.78	92.22
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	.14	-*	1.50
" fibre,	1.73	-*	1.41
" fat,	4.60	8.74	19.68
" protein,	37.09	43.86	38.57
Nitrogen-free extract matter,	56.44	-*	38.84
	100.00	-	100.00

* Not determined.

7. MISCELLANEOUS FODDER ANALYSES — *Continued.*

Atlas Meal.

[Dry distillery feed, sent on from Peoria, Ill.]

	Per Cent.
Moisture at 100° C.,	11.21
Dry matter,	88.75
	100.00
Analysis of Dry Matter.	
Crude ash,	.41
" fibre,	11.94
" fat,	15.28
" protein,	37.30
Nitrogen-free extract matter,	35.07
	100.00
Fertilizing Constituents.	
Moisture at 100° C.,	11.21
Potassium oxide,	.16
Phosphoric acid,	.23
Nitrogen,	5.30

This article is new in our market. German experiment station reports speak of two kinds of dry distillery feed, one obtained in connection with the manufacture of alcohol from rye and one from maize; the former contains considerable less crude protein (from twenty-two to thirty per cent.) than the latter (from thirty to thirty-four per cent.).

[I., Buffalo gluten feed, from station barn; II., golden gluten, sent on from Boston, Mass.; III., Chicago maize feed, sent on from Boston, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C.,	8.34	9.89	7.19
Dry matter,	91.66	90.11	92.81
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	.91	-*	1.06
" fibre,	8.61	-*	9.34
" fat,	14.76	15.78	7.39
" protein,	25.09	29.13	27.07
Nitrogen-free extract matter,	50.63	-*	55.14
	100.00	-	100.00

* Not determined.

7. MISCELLANEOUS FODDER ANALYSES — *Continued.*

[I., gluten feed, sent on from Lincoln, Mass.; II, oil cake, sent on from Boston, Mass.; III., gluten feed, sent on from Lincoln, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C.,	8.52	11.01	8.52
Dry matter,	91.48	88.99	91.48
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	-*	2.35	-*
" fibre,	-*	8.37	-*
" fat,	15.94	18.32	14.58
" protein,	24.21	25.21	22.15
Nitrogen-free extract matter,	-*	45.75	-*
	-	100.00	-

[I., Peoria gluten feed, sent on from Peoria, Ill.; II., Chicago gluten, sent on from Lincoln, Mass.; III., gluten feed, sent on from Lincoln, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C.,	7.07	9.22	9.79
Dry matter,	92.93	90.78	90.21
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	1.16	-*	-*
" fibre,	8.30	-*	-*
" fat,	14.33	8.98	9.07
" protein,	22.71	22.87	21.00
Nitrogen-free extract matter,	53.50	-*	-*
	100.00	-	-

* Not determined.

7. MISCELLANEOUS FODDER ANALYSES — *Continued.*

[I., combination horse feed, sent on from Amherst, Mass.; II., corn, oats and barley chop, sent on from Springfield, Mass.; III., ground corn and oats chop, sent on from Springfield, Mass.; IV., Iowa gluten meal, sent on from Amherst, Mass.; V., cotton-seed meal, sent on from Amherst, Mass.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C., . . .	10.84	9.85	7.98	8.31	7.29
Dry matter, ...	89.16	90.15	92.02	91.69	92.71
	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.					
Crude ash, ...	5.69	4.14	2.35	1.24	7.63
" cellulose, . . .	19.92	8.48	14.62	4.52	5.91
" fat, ...	1.74	5.54	3.83	10.97	8.41
" protein, ...	11.22	13.75	9.13	36.40	48.79
Nitrogen-free extract matter, .	61.43	68.09	70.07	46.87	29.26
	100.00	100.00	100.00	100.00	100.00

[I., Chicago maize feed, sent on from Boston, Mass.; II., Peoria gluten feed, sent on from Peoria, Ill.; III., Buffalo gluten feed, from station barn; IV., wheat bran, from station barn; V., barley meal, from station barn.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C., . . .	7.19	7.07	9.37	9.15	11.17
Dry matter, ...	92.81	92.93	90.63	90.85	88.83
	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.					
Crude ash, ...	1.06	1.16	.86	6.10	2.79
" cellulose, . . .	9.34	8.30	8.17	11.06	8.03
" fat, ...	7.39	14.33	14.71	6.10	2.51
" protein, ...	27.07	22.71	23.16	18.29	9.99
Nitrogen-free extract matter, .	55.14	53.50	53.10	58.45	76.68
	100.00	100.00	100.00	100.00	100.00

7. MISCELLANEOUS FODDER ANALYSES — *Continued.*

[I. and II., cotton-seed meal, sent on from Longmeadow, Mass.; III., cotton-seed meal, sent on from Williamsburg, Mass.; IV., Chicago germ feed, sent on from Weston, Mass ; V., oat feed, sent on from North Amherst, Mass.: VI., ground oats, sent on from North Amherst, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C.,	5.87	5.82	6.35	7.35	6.75	8.89
Dry matter,	94.13	94.18	93.65	92.65	93.25	91.11
	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.						
Crude fat,	11.55	10.85	9.30	13.18	4.83	4.52
" protein,	50.19	47.78	51.38	11.06	11.93	11.93

[I., gluten feed, sent on from Lincoln, Mass.; II., gluten feed, sent on from Lincoln, Mass.]

	PER CENT.	
	I.	II.
Moisture at 100° C.,	8.52	8.61
Dry matter,	91.48	91.39
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	–*	–*
" fibre,	–*	–*
" fat,	14.59	12.70
" protein,	22.15	16.81
Nitrogen-free extract matter,	–*	–*

* Not determined.

7. MISCELLANEOUS FODDER ANALYSES — *Continued.*

[I., peanut cake (Germany); II., peanut husks from Amherst, Mass.]

	Per Cent.	
	I.	II.
Moisture at 100° C,	-	12.98
Dry matter,	-	87.02
	-	100.00
Analysis of Dry Matter.		
Crude ash,	-	1.36
" fibre,	-	75.91
" fat,	8—12	1.90
" protein,	42—52	5.74
Nitrogen-free extract matter,	-	15.09
	-	100.00
Fertilizing Constituents.		
Moisture at 100° C,	-	12.98
Phosphoric acid,	-	.13
Potassium oxide,	-	.48
Nitrogen,	6—8	.80

[I., Peoria gluten feed, sent on from North Amherst, Mass.; II., King gluten meal, sent on from New York, N. Y.; III., Iowa gluten meal, sent on from Beverly, Mass.; IV., rye feed, sent on from Westborough, Mass.; V., oat feed, from station barn.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	7.50	6.65	7.33	8.23	6.50
Dry matter,	92.50	93.35	92.67	91.77	93.50
	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.					
Crude ash,	.90	2.19	-*	3.34	10.02
" cellulose,	8.86	1.62	-*	3.62	17.73
" fat,	13.62	21.44	16.08	3.04	3.95
" protein,	21.35	36.19	31.56	16.62	11.02
Nitrogen-free extract matter,	55.27	38.56	-*	73.38	57.28
	100.00	100.00	-	100.00	100.00

* Not determined.

7. MISCELLANEOUS FODDER ANALYSES — *Continued.*

[I., peanut feed, sent on from Granby, Mass.; II., peanut feed, sent on from Boston, Mass.]

	PER CENT.	
	I.	II.
Moisture at 100° C.,	9.08	10.92
Dry matter,	90.92	89.08
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	2.25	3.60
" fibre,	62.48	62.82
" fat,	7.61	4.49
" protein,	10.31	9.54
Nitrogen-free extract matter,	17.35	19.55
	100.00	100.00
Fertilizing Constituents.		
Moisture at 100° C.,	9.07	10.92
Phosphoric acid,	.23	-*
Potassium oxide,	.79	-*
Nitrogen,	1.50	1.36

[I., meat meal, sent on from New York; II., German analysis, sent on.]

	PER CENT.	
	I.	II.
Moisture at 100° C.,	8.00	-
Dry matter,	92.00	-
	100.00	-
Analysis of Dry Matter.		
Crude ash,	-*	-
" fibre,	-*	-
" fat,	20.73	12.70
" protein,	76.15	73.50
Nitrogen-free extract matter,	-*	-
Fertilizing Constituents.		
Moisture at 100° C.,	8.00	-
Phosphoric acid,	.73	-
Potassium oxide,	.30	-
Nitrogen,	11.21	11.70

* Not determined.

This meal is a refuse from the manufacture of Liebig's extract of meat. In the process of manufacture it has lost its salines, and in feeding the meal these are replaced in the form of chemicals.

7. MISCELLANEOUS FODDER ANALYSES — *Continued.*

[I., late soja bean, station, cut July 10, 1893, twelve to thirteen inches high, not in bloom; II., early black soja bean, station, cut July 10, 1893, sixteen to seventeen inches high, on point of blooming; III., early white soja bean, station, cut July 10, 1893, fourteen inches high, just before blooming; IV., early white soja bean, station, cut July 10, 1893, sixteen to seventeen inches high, before blooming.]

	PER CENT.			
	I.	II.	III.	IV.
Moisture at 100° C.,	77.09	82.21	79.51	74.97
Dry matter,	22.91	17.79	20.49	25.03
	100.00	100.00	100.00	100.00
Analysis of Dry Matter.				
Crude ash,	14.36	12.86	14.36	11.85
" cellulose,	16.47	25.06	23.41	23.23
" fat,	3.34	3.38	2.97	2.16
" protein,	22.16	16.18	14.34	13.81
Nitrogen-free extract matter,	43.67	42.52	44.92	48.95
	100.00	100.00	100.00	100.00
Total nitrogen,	3.54	2.59	2.29	2.21
Amide nitrogen,	.79	.55	.68	.31

[I., rowen from station barn; II., carrots, raised on station grounds; III., beets, raised on station grounds.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C.,	18.64	88.01	83.71
Dry matter,	81.36	11.99	16.29
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	7.62	7.98	6.79
" cellulose,	26.09	9.00	5.84
" fat,	3.28	2.03	.71
" protein,	14.42	7.29	13.27
Nitrogen-free extract matter,	48.59	73.70	73.39
	100.00	100.00	100.00
Fertilizing Constituents.			
Moisture at 100° C.,	18.640	88.010	83.710
Potassium oxide,	1.682	.441	.463
Phosphoric acid,	.574	.095	.111
Nitrogen,	1.876	.140	.346
Insoluble matter,	1.533	.029	.111

7. MISCELLANEOUS FODDER ANALYSES — *Concluded.*

[I., potatoes, station, raised on Plat 1, Field C, with muriate of potash; II., potatoes, station, raised on Plat 4, Field C, with sulphate of potash; III., potatoes from station barn.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C.,	80.71	81.17	78.67
Dry matter,	19.29	18.83	21.33
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	4.71	4.64	4.76
" fibre,	2.26	2.35	2.30
" fat,	.54	.42	.62
" protein,	10.98	10.06	9.56
Nitrogen-free extract matter,	81.51	82.53	82.76
	100.00	100.00	100.00
Starch,	13.44	13.15	–*
Starch in dry matter,	69.66	70.31	–*
Fertilizing Constituents.			
Moisture at 100° C.,	80.710	81.170	78.670
Calcium oxide,	.018	.020	–*
Magnesium oxide,	.044	.041	–*
Potassium oxide,	.607	.553	.589
Sodium oxide,	.029	.024	–*
Phosphoric acid,	.065	.048	.134
Nitrogen,	.338	.303	.326
Insoluble matter,	.026	.048	.036

* Not determined.

Apple Pomace.

[Sent on from Sherborn, Mass.]

	Per Cent.
Moisture at 100° C.,	87.51
Dry matter,	12.49
	100.00
Analysis of Dry Matter.	
Crude ash,	3.36
" fibre,	21.67
" fat,	5.93
" protein,	5.75
Nitrogen-free extract matter,	63.29
	100.00

C. *Discussion on Commercial Feed Stuffs.*

By C. A. Goessmann.

The name commercial feed stuff or concentrated commercial feed stuffs is usually applied to a class of substances offered for sale in our markets which, in the majority of cases, are the waste or by-products of other branches of industry. Some of these articles, as brans, middlings and oil cakes, have been for years quite generally used in the daily diet of all kinds of farm live stock; others, as the gluten meal, gluten feed, corn germ meal, dried brewers' grain, malt sprouts, dry distillery feed, etc., have been but recently more generally offered for a similar purpose.

Their importance as an additional valuable fodder supply for the support of every branch of animal industry on the farm and elsewhere has become from year to year more conspicuous, on account of a marked increase of the supply of well-known articles, as well as of the introduction of many new kinds. Their consumption is apparently daily increasing, and seems to keep step with the supply.

The special value claimed for commercial feed stuffs as an important source of fodder supply rests in the main on their fitness to supplement advantageously our coarse home-raised fodder crop in the interest of a higher feeding effect and of a better economy. A frequently good mechanical condition, as well as an exceptionally valuable chemical composition, adapt many of them in a high degree for that purpose.

As no single farm crop or any part of it has been found to supply economically and efficiently to any considerable extent the particular wants of food of our various kinds of farm live stock, to secure the best possible results, it becomes a matter of first importance from a mere financial stand-point to know how to supplement our current farm crops to meet the wants of each kind of animals under various circumstances in a desirable degree. To secure the highest feeding effect of each fodder article raised upon the farm is most desirable in the interest of good economy.

Practical experience in the dairy has thus far abundantly shown that the efficiency of a daily diet does not so much depend on the mere use of more or less of one or the other reputed fodder article as on the presence of suitable fodder articles which contain the *three essential groups of food constituents*, i. e., *organic nitrogenous, non-nitrogenous and mineral constituents of plants*, in a desirable form, and in such relative proportions and quantities as have been recognized to be necessary to meet efficiently the food supply of the dairy cow. Similar relations are known to exist in regard to the diet best adapted in case of all kinds of animals. *An economical system of stock feeding has to select among the suitable fodder articles those which furnish the required quality and proportion of the three recognized essential food constituents in a digestible form, at the lowest cost.*

Actual observations in stock feeding fully confirm the correctness of the above statement, that a judicious selection from among the current commercial feed stuffs, for the purpose of serving in connection with one or more of our home-raised fodder plants as a fodder ingredient of the daily diet, does, as a rule, tend not only to improve their food value, but also lowers in the majority of cases the net cost of the feed consumed. For more details regarding the determination of the intrinsic value of fodder rations I have to refer on the present occasion, for obvious reasons, to preceding annual reports.

The majority of commercial feed stuffs occupy in a rational system of stock feeding a similar position to our home-raised fodder crops as is commonly conceded to the commercial fertilizer with reference to the barn-yard manure for the production of farm crops; they serve for the preparation of a complete diet under different conditions and for different purposes. The individual merits of each of them become in the same degree better appreciated as the principles which govern animal nutrition are *more generally* understood, and *find a due recognition* in our modes of compounding the daily diet for different kinds as well as for different conditions of the same kind of animals. *They are as a class today considered indispensable for a remunerative management of every branch of animal industry on the farm and elsewhere.*

Many of the commercial feed stuffs contain, aside from a liberal amount of phosphoric acid and potash, an exceptionally large percentage of nitrogen. This circumstance gives them a special claim, independent of their respective food value for animals. A liberal addition of these feed stuffs to the daily diet of any kind of animal imparts to the manurial refuse resulting from their use a corresponding higher commercial and agricultural value as a valuable source of plant food. A judicious and liberal introduction of a quite numerous class of commercial feed stuffs into the daily fodder supply of the animals kept on the farm is for this reason *deservedly* recommended as a safe and economical way to increase the home production of plant food in the interest of an increase in the fertility of the farm lands.

As the financial success of a mixed system of farming in particular depends to a considerable degree on the character, the amount and the cost of production of the manurial refuse secured in connection with the special farm industry carried on at the time, it seems to need no further argument to prove that the relation which exists between the temporary *market cost* of the particular feed stuff under consideration and the *market value* of the manurial elements which it contains deserves a serious consideration when devising an efficient and at the same time an economical diet.

The character and commercial value of the manurial refuse obtainable from any kind of feed stuff, under otherwise corresponding conditions, stand in a direct relation to more or less of the different essential fertilizing constituents — phosphoric acid, potash and, in particular, nitrogen — it contains. The commercial value of these three important articles of plant food found frequently in prominent commercial feed stuffs equals in many instances more than one-half of the market cost of the particular fodder ingredient in question.

The subsequent tabular statement may serve as an illustration of these relations between market cost and fertilizing value of some current reputed fodder articles: —

NAME OF FEED STUFFS.	Market Cost (per Ton).	Manurial Value (per Ton).
Corn meal,	$24 00	$7 31
Gluten meal (Chicago),	28 00	14 72
Chicago maize feed,	25 00	13 25
Buffalo gluten feed,	23 00	12 57
Cotton-seed meal,	28 00	23 52
Linseed meal (old process),	26 00	19 22
Linseed meal (new process),	27 00	20 37
Wheat middlings,	17 00	9 50
Wheat bran,	17 00	13 23
Dried brewers' grain,	23 00	9 96
English hay (first cut of meadows),	15 00	5 92
Rowen (second cut of meadows),	15 00	7 00
Corn fodder,	7 00	4 55
Corn stover,	5 00	3 75
Corn ensilage,	2 50	1 53
Sugar beets,	5 00	1 21
Mangold roots,	4 00	1 01

The above-stated market cost is subject to periodical changes, and the commercial value of their fertilizing constituents varies more or less with the quality of each kind. This feature does not affect materially the force of the point made.

A due appreciation of the previously pointed out favorable features regarding the peculiar character of a numerous class of commercial feed stuffs has caused a steady increase in their consumption on the farm and elsewhere. *The money invested by farmers for securing commercial feed stuffs as an additional food supply for home consumption exceeds to-day many times the amount spent for commercial fertilizers.*

As no single commercial feed stuff can be expected to meet our present demand for these articles, nor can claim to be the most economical one under varying market conditions, and with due appreciation of the varying character of our home-raised fodder supply, it is but proper that every new addition in suitable kinds should receive a deserved attention, and subsequently an actual trial to ascertain its individual merits.

A considerable number of these feed stuffs has already been tried at this station during past years, in connection with our feeding experiments with milch cows, growing steers, lambs and pigs, as may have been noticed in our periodical reports; others are at present on trial.

Commercial feed stuffs are usually bought for their high percentage of either nitrogen-containing organic matter or fat, or both. They are used to enrich the daily diet of various kinds of farm live stock in both directions. This course is generally adopted on account of a well-known deficiency of most of our home-raised coarse fodder articles in regard to both food constituents, in particular, of nitrogenous matter. Farmers that do not raise a liberal proportion of clover-like fodder plants are in a particular degree in need of concentrated commercial feed stuffs rich in nitrogenous food constituents to turn the excess of the non-nitrogenous food constituents which most of our current home-raised coarse fodder articles contain to the best possible account.

The liability of pecuniary losses on the part of the buyer, in consequence of exceptional variations in the percentage of nitrogenous organic matter, crude protein or fat, or of both, is quite frequently greatly aggravated by most unexpected serious fluctuations in the market cost of leading feed stuffs.

As we buy in the majority of cases the concentrated commercial feed stuffs on account of their large proportion of nitrogen-containing food constituents, it becomes of special interest to know at what cost *a given quantity of nitrogen-containing food constituents* can be bought in the form of different feed stuffs equally well adapted under existing circumstances. A change in the *market cost* of one and the same commercial feed stuff affects the cost of the nitrogen-containing food constituent in particular, as its supply is more limited than that of the non-nitrogenous food constituents which our home-raised coarse fodder articles contain, as a rule, in abundance, and which, therefore, need not be secured from outside resources for cash.

The subsequent tabular statement assumes a constant cost of digestible non-nitrogenous food constituents, — sugar, starch, fat, etc., — and shows thereby the variations in the cost of digestible nitrogen-containing food constituents in case of some prominent concentrated commercial feed stuffs in our local market.

The majority of analyses stated are made of fodder articles which have been used either during the past years in connection with some of our feeding experiments, or have been raised upon the grounds of the station. Some articles sent on by outside parties are added, on account of the special interest they may present to others.

Valuation of Fodder Articles on the Following Basis.

[Digestible cellulose and nitrogen-free extract matter, 1 cent per pound; digestible fat, 2¼ cents per pound. The value of digestible protein determined the difference of the sum of both and the market cost of the fodder articles. (Calculation is based on dry matter, 2,000 pounds.)]

	Market Cost.	Protein per Pound (Cents).
Corn meal,	$31 00	6.88
Corn meal,	29 00	5.84
Corn meal,	24 00	3.24
Corn meal,	23 00	2.72
Wheat middlings,	20 00	3.13
Spring wheat bran,	19 00	3.04
Winter wheat bran,	21 00	3.93
Chicago maize feed,	23 00	2.34
Dried brewers' grain,	22 00	3.37
Old-process linseed meal,	26 00	2.20
New-process linseed meal,	27 00	2.68
Chicago gluten meal,	28 00	2.46
Cotton-seed meal,	28 00	2.34
English hay,	12 00	1.36
English hay,	15 00	4.12
Rowen,	12 00	1.21
Rowen,	15 00	3.24
Corn stover,*	5 00	–
Corn ensilage,*	2 50	–
Mangold roots,*	3 00	–
Sugar beets,*	5 00	–

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* The value of the digestible cellulose, nitrogen-free extract matter and fat, on the above basis, exceeds the market cost.

The present condition of the trade in commercial concentrated feed stuffs deserves the serious attention of dealers and consumers for the following reasons: —

Prices are apt to rise and to fall without any reference to the agricultural value of the article in question.

Names may remain the same, and in fact do remain in some instances, while the composition of the article suffers *serious changes in consequence of changes in the parent industry.*

Sales without due responsibility regarding the particular quality of the goods delivered leave the pecuniary risk involved in the transaction in an objectionable degree on the side of the buyer.

Unaccounted-for variations in the composition of feed stuffs must prove a serious obstacle in the desirable introduction of a rational and economical system of stock feeding.

For these and other reasons previously pointed out it cannot be claimed that the prevailing mode of selling and buying commercial feed stuffs rests on a just and fairly equitable basis.

The trade in commercial feed stuffs is to-day in a similar unsatisfactory condition as was the trade in commercial fertilizers before the introduction of a system of State inspection in regard to those articles.

The best interests of both manufacturers and farmers, in fact of every one who keeps live stock for his accommodation, render such changes desirable in the present mode of selling and buying feed stuffs as will impose mutual and equitable responsibility on all parties interested in the transaction. The limited margins for profit in every branch of animal industry carried on at our farms necessitate a careful attention to all the details of the business. The money interests involved are of an exceptional magnitude.

II.

ANALYSES OF MILK SENT ON FOR EXAMINATION.

[Per Cent.]

Number of Samples.	Solids.	Fat.	Solids not Fat.	Locality.	Remarks.
1, . .	12.50	3.69	8.81	Northborough.	
2, . .	12.13	4.27	7.86	Westborough.	
3, . .	12.19	4.50	7.69	Westborough.	
4, . . .	11.62	4.25	7.37	Westborough.	
5, . .	12.20	3.39	8.81	Westborough.	
6, . .	13.18	4.23	8.95	Westborough.	
7, . .	12.55	3.36	9.05	New Braintree.	
8, . .	12.78	4.05	8.73	Westborough.	
9, . .	14.31	5.03	9.28	North Amherst.	
10, . .	12.85	3.51	9.34	Barre.	
11, . .	10.20	2.10	8.10	Barre.	
12, . .	12.12	3.64	8.48	Barre.	
13, . .	12.50	3.71	8.89	Barre.	
14, . .	12.61	3.71	8.90	Barre.	
15, . .	13.04	4.19	8.85	Barre.	
16, . .	11.54	3.42	8.12	Barre.	
17, . .	12.71	3.82	8.89	New Braintree.	
18, . .	12.10	3.25	8.85	New Braintree.	
19, . .	10.76	2.13	8.63	New Braintree.	
20, . .	11.15	2.88	8.27	New Braintree.	
21, . .	12.18	3.55	8.63	New Braintree.	

ANALYSES OF MILK SENT ON FOR EXAMINATION — *Concluded.*

Number of Samples.	Solids.	Fat.	Solids not Fat.	Locality.	Remarks.
22, . .	13.30	3.65	9.65	New Braintree.	
23, . .	12.52	3.18	9.34	New Braintree.	
24, . .	12.59	3.68	8.91	New Braintree.	
25, . .	13.78	4.37	9.41	New Braintree.	
26, . .	13.39	4.13	9.26	New Braintree.	
27, . .	10.99	2.50	8.49	Westborough.	
28, . .	11.38	3.00	8.38	Westborough.	
29, . .	11.53	3.00	8.53	Westborough.	
30, . .	10.63	2.10	8.53	Westborough.	
31, . .	11.14	2.90	8.24	Westborough.	
32, . .	12.03	3.30	8.73	Westborough.	
33, . .	13.01	4.60	8.41	Westborough.	
34, . .	11.08	2.80	8.28	Westborough.	
35, . .	11.68	3.20	8.48	Westborough.	
36, . .	12.90	3.60	9.30	Barre Plains.	
37, . .	17.20	7.90	9.30	Norton.	
38, . .	12.83	4.06	8.77	Barre Plains.	
39, . .	12.14	3.66	8.48	Gilbertville.	
40, . .	12.25	3.61	8.64	Barre Plains.	

III.

ANALYSES OF WATER SENT ON FOR EXAMINATION.*

[Parts per million.]

NUMBER.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Hardness (Clark's Degree).	Solids at 100° C.	Solids at Red Heat.	Lead.	Locality.
1	.040	.112	3.00	3.25	176.00	56.00	-	Concord.
2	.036	.184	8.00	2.21	104.00	28.00	-	Northborough.
3	.056	.112	6.00	.79	116.00	32.00	-	Northborough.
4	.012	.028	2.00	1.82	104.00	86.00	-	Leverett.
5	.180	.234	6.00	.71	62.00	28.00	-	Barre.
6	.024	.104	25.00	9.71	330.00	134.00	-	Barre.
7	.068	.148	41.00	11.35	484.00	166.00	-	Barre.
8	.066	.194	14.00	3.51	156.00	44.00	-	Barre.
9	Trace.	.134	18.00	4.43	186.00	94.00	-	Weston.
10	.134	.144	5.00	.56	50.00	16.00	-	Barre.
11	.030	.060	5.00	.24	46.00	12.00	-	Barre.
12	.176	.100	104.00	7.14	380.00	168.00	-	Amherst.
13	.040	.088	8.00	1.56	108.00	60.00	None.	Amherst.
14	.056	.152	6.00	3.25	188.00	92.00	-	Amherst.
15	.048	.088	9.00	.16	84.00	28.00	-	Northfield.
16	.072	.096	20.80	4.57	160.00	64.00	-	Northfield.
17	.044	.096	13.00	2.86	164.00	68.00	-	Littleton.
18	.038	.044	4.00	.32	56.00	16.00	-	Holyoke.
19	.044	.036	4.00	-	80.00	24.00	-	Holyoke.
20	.072	.080	6.00	.16	60.00	36.00	-	Holyoke.
21	.084	.080	26.00	4.16	80.00	32.00	-	Westminster.
22	.060	.020	5.00	10.35	292.00	148.00	-	Springfield.
23	Trace.	Trace.	5.00	5.43	196.00	124.00	-	Springfield.
24	.016	.012	5.00	11.80	300.00	150.00	-	Springfield.
25	.022	.012	20.00	2.60	112.00	20.00	-	North Amherst.

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* Analysis of well water at the station is confined to chemical tests with reference to an excess of foreign matter from sinks, barns, etc.

ANALYSES OF WATER, ETC. — *Continued.*

NUMBER.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Hardness (Clark's Degree).	Solids at 100° C.	Solids at Red Heat.	Lead.	Locality.
26	.008	.008	7.00	5.43	118.00	48.00	-	Leverett.
27	.024	.052	4.00	1.95	52.00	32.00	-	South Deerfield.
28	.024	.040	12.00	1.82	94.00	40.00	-	Weston.
29	.020	.036	10.00	1.82	-	-	-	Weston.
30	1.000	.920	24.00	7.02	308.00	104.00	-	South Deerfield.
31	.440	.208	10.00	3.12	140.00	68.00	-	Littleton.
32	.296	.184	14.00	1.69	130.00	40.00	-	Littleton.
33	.036	.136	6.00	.49	144.00	60.00	-	Littleton.
34	.160	.288	40.00	9.71	470.00	168.00	-	Lancaster.
35	.116	.128	8.00	2.21	78.00	46.00	-	New Braintree.
36	.012	.148	6.00	1.43	62.00	20.00	-	New Braintree.
37	.016	.180	12.00	2.21	96.00	12.00	-	Brockton.
38	.312	.360	14.00	3.64	176.00	74.00	-	East Lexington.
39	.120	.116	6.00	1.11	55.84	-	-	Lowell.
40	.020	.384	6.00	1.11	90.00	26.00	-	Springfield.
41	.128	.520	6.00	.95	76.00	20.00	-	Springfield.
42	.032	.168	4.00	1.95	80.00	26.00	-	Amherst.
43	.020	.108	5.00	.95	140.00	60.00	-	Hadley.
44	.024	.102	8.00	1.95	104.00	48.00	-	Amherst.
45	.024	.180	10.00	1.95	-	-	-	Amherst.
46	.008	.096	4.00	.95	72.00	24.00	None.	Amherst.
47	.004	.092	4.00	.95	80.00	28.00	-	Amherst.
48	.016	.086	7.00	2.21	112.00	52.00	-	Kendall Green.
49	.008	.060	6.00	1.95	112.00	52.00	-	Kendall Green.
50	.016	.144	4.00	1.95	104.00	28.00	-	Kendall Green.
51	.144	.264	8.00	-	100.00	20.00	-	Pelham.
52	.036	.204	6.00	-	-	-	-	Pelham.
53	.016	.192	4.00	-	-	-	-	Pelham.
54	.032	.068	22.00	-	-	-	-	Amherst.
55	.060	.096	4.00	4.86	76.00	24.00	-	Greenfield.
56	.300	-	12.00	-	-	-	-	Amherst.
57	.076	.084	96.00	-	-	-	-	Amherst.
58	.008	.068	40.00	-	-	-	-	Hadley.
59	.120	-	8.00	-	-	-	-	Amherst.

ANALYSES OF WATER, ETC. — *Continued.*

NUMBER.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Hardness (Clark's Degree).	Solids at 100° C.	Solids at Red Heat.	Lead.	Locality.
60	.028	.152	18.00	-	-	-	Present.	Amherst.
61	.036	.084	34.00	-	-	-	-	Amherst.
62	None.	.040	12.00	4.03	-	-	-	Amherst.
63	.076	.496	18.00	-	-	-	-	Amherst.
64	.024	.092	20.00	-	-	-	-	Amherst.
65	.028	.124	7.00	-	-	-	-	Amherst.
66	.024	.244	8.00	-	-	-	-	Amherst.
67	.072	.064	14.00	5.14	196.00	64.00	-	Springfield.
68	.040	.308	4.00	.48	160.00	60.00	-	Springfield.
69	None.	.092	6.00	-	-	-	-	Amherst.
70	.096	.112	8.00	-	-	-	-	Amherst.
71	.022	.242	8.00	-	-	-	-	South Deerfield.
72	.212	.108	6.00	5.29	-	-	-	Lawrence.
73	.088	.232	8.00	2.99	-	-	-	Lawrence.
74	.144	.184	12.00	2.99	-	-	-	Lawrence.
75	.024	.092	36.00	-	-	-	-	Amherst.
76	.010	.162	5.00	-	-	-	-	Pelham.
77	.004	.044	7.00	-	-	-	-	Medway.
78	None.	.072	48.00	4.29	-	-	-	Worcester.
79	Trace.	.082	16.00	-	-	-	-	Amherst.
80	1.840	-	16.00	-	-	-	-	Amherst.
81	.012	.448	4.00	.95	134.00	30.00	-	Pelham.
82	.040	.188	14.00	-	-	-	-	Amherst.
83	.016	.320	12.00	4.57	-	-	-	Amherst.
84	.008	.184	4.00	.95	-	-	-	Amherst.
85	.006	.040	7.00	1.69	46.00	4.00	-	Worcester.
86	.348	.128	6.00	1.27	29.00	8.00	-	Weston.
87	.032	.136	20.00	3.51	174.00	40.00	-	Dighton.
88	.108	.920	19.00	6.29	280.00	80.00	-	Templeton.
89	.076	.104	60.00	4.29	-	-	-	Amherst.
90	.120	.064	10.00	6.71	-	-	None.	Amherst.
91	.024	.068	7.00	-	-	-	-	North Amherst.
92	.044	.148	10.00	-	-	-	-	North Amherst.
93	.016	.164	15.00	-	-	-	-	Amherst.

ANALYSES OF WATER, ETC. — *Continued.*

NUMBER.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Hardness (Clark's Degree).	Solids at 100° C.	Solids at Red Heat.	Lead.	Locality.
94	.240	.120	10.00	-	-	-	-	South Deerfield.
95	.540	.440	16.00	-	-	-	-	Amherst.
96	.044	.080	12.00	-	-	-	-	Amherst.
97	.465	.210	4.00	-	-	-	-	Amherst.
98	.012	.176	22.00	5.43	272.00	36.00	-	Springfield.
99	.120	.056	18.00	-	-	-	-	Amherst.
100	Trace.	.072	27.00	-	-	-	-	Amherst.
101	Trace.	.100	86.00	10.00	-	-	-	Amherst.
102	.032	.120	21.00	6.43	-	-	-	Amherst.
103	.052	.061	14.00	2.60	-	-	-	Amherst.
104	.064	.042	10.00	1.43	132.00	60.00	-	Barre.
105	.072	.152	12.00	2.21	-	-	-	Methuen.
106	.016	.088	9.00	2.73	-	-	-	Amherst.
107	.004	.250	16.00	2.34	-	-	-	Amherst.
108	.380	.260	31.00	-	-	-	-	Amherst.
109	.460	-	19.00	-	-	-	-	Amherst.
110	.010	.248	4.00	-	96.00	24.00	-	Pelham.
111	Trace.	.070	20.00	5.29	-	-	-	Amherst.
112	None.	.110	13.00	-	-	-	-	Amherst.
113	.074	.106	37.00	10.30	-	-	-	Newburyport.
114	2.300	-	34.00	-	-	-	-	Amherst.
115	.024	.108	51.00	-	-	-	-	Amherst.
116	.044	.072	6.00	-	-	-	None.	North Amherst.
117	.072	.172	6.00	-	-	-	-	Petersham.
118	.030	.150	8.00	.95	-	-	-	Amherst.
119	.024	.178	5.00	.79	-	-	-	Coldbrook Springs.
120	.004	.044	12.00	-	-	-	None.	Amherst.
121	.016	.140	7.00	4.29	-	-	-	Amherst.
122	.012	.074	16.00	2.08	140.00	42.00	-	Amherst.
123	.048	.068	4.00	-	-	-	-	Leverett.
124	.008	.064	9.00	-	-	-	-	Amherst.
125	.004	.064	6.00	-	-	-	-	Amherst.
126	.008	.056	10.00	-	-	-	-	Berlin.
127	.046	.164	30.00	-	226.00	76.00	-	Amherst.

ANALYSES OF WATER, ETC. — *Continued.*

NUMBER.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Hardness (Clark's Degree).	Solids at 100° C.	Solids at Red Heat.	Lead.	Locality.
128	.120	.190	12.00	-	-	-	-	Amherst.
129	Trace.	.076	8.00	-	-	-	-	Amherst.
130	.020	.100	6.00	-	-	-	-	Petersham.
131	.108	.264	9.00	-	-	-	-	South Amherst.
132	Trace.	.253	5.00	-	-	-	-	Holyoke.
133	Trace.	.070	8.00	-	-	-	-	Amherst.
134	None.	.084	10.00	-	-	-	-	Amherst.
135	.060	.040	9.00	3.77	-	-	-	Westford.
136	.680	.350	9.00	5.57	-	-	-	Westford.
137	.016	.116	10.00	-	-	-	-	Amherst.
138	.200	.152	16.00	-	-	-	-	Amherst.
139	.076	.312	7.00	-	-	-	-	Northborough.
140	.084	.240	6.00	1.11	78.00	46.00	-	Pelham.
141	.016	.385	20.00	-	-	-	-	East Lexington.
142	.008	.054	9.00	2.99	-	-	-	Amherst.
143	None.	.020	7.00	.48	-	-	-	Amherst.
144	.080	.060	9.00	1.82	-	-	-	Amherst.
145	.014	.026	8.00	.48	-	-	Present.	North Brookfield.
146	.008	.088	12.00	-	-	-	-	Amherst.
147	Trace.	.352	8.00	-	-	-	Present.	Amherst.
148	.136	.224	18.00	6.86	-	-	-	Amherst.
149	.012	.120	10.00	4.08	160.00	58.00	-	North Hadley.
150	.008	.188	16.00	7.43	238.00	104.00	-	Williamsburg.
151	.068	.100	4.00	1.95	84.00	12.00	-	Westhampton.
152	.012	.240	4.00	.56	70.00	20.00	-	Amherst.
153	.622	-	166.00	-	-	-	-	North Hadley.
154	.128	.208	5.00	-	-	-	-	Monterey.
155	.040	.264	8.00	-	-	-	-	Amherst.
156	.024	.264	8.00	-	-	-	-	Amherst.
157	.012	.072	9.00	2.73	88.00	20.00	-	Chelmsford.
158	-	.200	5.00	-	74.00	20.00	-	Amherst.
159	.176	.192	5.00	.79	76.00	12.00	-	Amherst.
160	.072	.076	50.00	9.14	274.00	104.00	-	North Andover.
161	.040	.208	8.00	-	-	-	-	West Acton.

ANALYSES OF WATER, ETC. — *Continued.*

NUMBER.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Hardness (Clark's Degree).	Solids at 100° C.	Solids at Red Heat.	Lead.	Locality.
162	.012	.180	4.00	-	60.00	22.00	-	Northfield.
163	.304	.184	6.00	-	60.00	22.00	-	Northfield.
164	.060	.096	4.00	4.86	76.00	24.00	-	Greenfield.
165	.040	.076	3.50	2.73	70.00	22.00	-	Greenfield.
166	.256	.072	18.00	3.51	166.00	32.00	-	Boston.
167	.036	.064	7.00	2.73	120.00	34.00	-	Boston.
168	.208	.176	5.00	.48	78.00	-	-	Amherst.
169	.208	.192	5.00	.48	80.00	20.00	-	Amherst.
170	.010	.214	4.00	.48	60.00	24.00	-	Amherst.
171	.028	.184	5.00	2.21	70.00	39.00	-	Greenfield.
172	.016	.144	4.00	3.90	104.00	64.00	-	Greenfield.
173	.036	.080	5.00	1.69	54.00	16.00	-	Greenfield.
174	.112	.080	7.00	-	-	-	-	Amherst.
175	.008	.120	11.00	3.25	124.00	38.00	-	Amherst.
176	None.	.092	18.00	5.14	246.00	96.00	-	Amherst.
177	Trace.	.252	8.00	4.29	128.00	76.00	-	Amherst.
178	.068	.160	26.00	-	-	-	-	North Amherst.
179	.064	.100	4.00	-	-	-	-	North Amherst.
180	-	-	-	4.03	138.00	90.00	-	Amherst.
181	.058	.088	21.00	9.43	270.00	112.00	-	Westford.
182	.050	.036	15.00	10.90	264.00	134.00	-	Westford.
183	.016	.248	5.00	.80	76.00	24.00	-	Amherst.
184	.012	.236	6.00	.80	76.00	20.00	-	Amherst.
185	.024	.120	6.00	4.29	384.00	60.00	-	Amherst.
186	.024	.032	8.00	2.73	96.00	36.00	-	Amherst.
187	.020	.108	28.00	2.21	184.00	48.00	-	Amherst.
188	.080	.220	12.00	1.69	84.00	28.00	-	South Framingham.
189	Trace.	.064	18.00	7.14	312.00	72.00	-	South Framingham.
190	.020	.128	8.00	2.73	68.00	28.00	-	South Framingham.
191	None.	.140	14.00	4.03	172.00	52.00	-	Amherst.
192	.016	.152	16.00	4.03	212.00	36.00	-	Amherst.
193	.012	.068	6.00	5.14	148.00	48.00	-	North Wilbraham.
194	.020	.136	32.00	6.29	260.00	92.00	-	North Amherst.
195	.148	.200	42.00	9.71	360.00	116.00	-	North Amherst.

ANALYSES OF WATER, ETC. — *Concluded.*

NUMBER.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Hardness (Clark's Degree).	Solids at 100° C.	Solids at Red Heat.	Lead.	Locality.
196	.100	.096	4.00	.48	48.00	24.00	-	Westford.
197	.048	.064	4.00	-	68.00	36.00	-	Amherst.
198	.036	.056	12.00	-	196.00	40.00	-	Amherst.
199	.012	.024	4.00	1.43	68.00	28.00	-	Amherst.
200	.156	.060	10.00	-	-	-	-	Amherst.

The analyses have been made according to Wancklyn's process, familiar to chemists, and are directed towards the indication of the presence of chlorine, free and albuminoid ammonia, and the poisonous metals, lead in particular. (For a more detailed description of this method, see "Water Analyses," by J. A. Wancklyn and E. T. Chapman.)

Mr. Wancklyn's interpretation of the results of his mode of investigation is as follows: —

1. Chlorine alone does not necessarily indicate the presence of filthy water.
2. Free and albuminoid ammonia in water, without chlorine, indicates a vegetable source of contamination.
3. More than five grains per gallon* of chlorine (=71.4 parts per million), accompanied by more than .08 parts per million of free ammonia and more than .10 parts per million of albuminoid ammonia, is a clear indication that the water is contaminated with sewage, decaying animal matter, urine, etc., and should be condemned.
4. Eight-hundredths parts per million of free ammonia and one-tenth part per million of albuminoid ammonia render a water very suspicious, even without much chlorine.
5. Albuminoid ammonia, over .15 parts per million, ought to absolutely condemn a water which contains it.
6. The total solids found in the water should not exceed forty grains per gallon (571.4 parts per million).

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* One gallon equals 70,000 grains.

An examination of the previously stated analyses indicates that Nos. 2, 5, 7, 8, 14, 30, 31, 32, 34, 36, 37, 38, 40, 41, 42, 51, 52, 53, 56, 57, 59, 60, 63, 66, 68, 71, 72, 73, 74, 76, 80, 81, 82, 83, 84, 86, 88, 92, 93, 94, 95, 97, 98, 105, 107, 108, 109, 110, 114, 117, 118, 119, 127, 128, 131, 132, 136, 138, 139, 140, 141, 147, 148, 150, 153, 154, 155, 156, 158, 159, 161, 162, 163, 168, 170, 171, 177, 178, 183, 184, 188, 192 and 195 ought to be condemned as unfit for family use; while Nos. 1, 3, 6, 9, 10, 12, 15, 16, 17, 20, 33, 35, 39, 43, 44, 45, 46, 47, 48, 50, 55, 61, 64, 65, 67, 70, 75, 78, 79, 87, 89, 90, 96, 99, 101, 102, 104, 112, 113, 115, 121, 130, 137, 149, 151, 152, 160, 164, 166, 172, 174, 175, 179, 185, 187, 190, 191, 194, 196 and 200 must be considered suspicious.

Parties sending on water for analysis ought to be very careful to use clean vessels, clean stoppers, etc. The samples should be sent on without delay after collecting. One-half gallon is desirable for the analysis.

The examinations of water, carried on at the station by request, are for various reasons confined simply to a chemical examination regarding the presence or absence of foreign injurious matter due to infiltration from objectionable sources (sewage, etc.). The recognition of the presence and absence of objectionable bacterial growth is left to experts in that direction.

IV. COMPILATION OF ANALYSES MADE AT AMHERST, MASS., OF AGRICULTURAL CHEMICALS AND REFUSE MATERIALS USED FOR FERTILIZING PURPOSES.

PREPARED BY C. S. CROCKER.

[As the basis of valuation changes from year to year, no valuation is stated.]

1868-1895.

This compilation does not include the analyses made of licensed fertilizers. They are to be found in the reports of the State Inspector of Fertilizers from 1873 to 1894, contained in the reports of the Secretary of the Massachusetts State Board of Agriculture for those years. C. A. G.

	Analyses.	Moisture.	Ash.	NITROGEN.			POTASH.			TOTAL PHOSPHORIC ACID.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
I. Chemicals, Refuse, Salts, Ashes, etc.																							
Muriate of potash, ...	70	1.91	-	-	-	-	58.98	45.94	51.06	-	-	-	-	-	-	6.69	-	.55	-	-	-	48.80	.70
Sulphate of potash, ...	24	2.55	-	-	-	-	51.28	21.36	34.99	-	-	-	-	-	-	4.46	-	1.50	-	45.72	-	-	.75
Sulphate of potash-magnesia, ...	19	4.77	-	-	-	-	29.48	16.96	24.06	-	-	-	-	-	-	6.25	2.57	-	-	44.25	-	2.60	1.41
Carbonate of potash, ...	1	26.86	-	-	-	-	-	-	18.48	-	-	-	-	-	-	-	-	19.52	-	-	-	-	.39
Phosphate of potash, ...	1	3.76	-	-	-	-	-	-	32.56	-	-	37.50	-	-	-	-	-	-	-	13.43	-	-	.92
Kainite, ...	4	3.20	-	-	-	-	16.48	12.51	13.54	-	-	-	-	-	-	18.97	1.15	9.80	-	20.25	-	33.25	2.18
Carnallite, ...	1	-	-	-	-	-	-	-	13.88	-	-	-	-	-	-	7.66	-	13.19	-	.56	-	41.56	-
Krugite, ...	1	4.82	-	-	-	-	-	-	8.42	-	-	-	-	-	-	5.27	12.45	8.79	-	31.94	-	6.63	14.96
Sulphate of magnesia (Kieserite), . .	9	22.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.82	17.30	-	36.10	-	-	5.73
Nitrate of potash, ...	4	1.30	-	14.58	11.60	12.71	45.62	44.76	45.27	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate of soda, ...	25	1.47	-	16.01	14.28	14.70	-	-	-	-	-	-	-	-	-	35.50	-	-	-	-	-	.50	.50
Sulphate of ammonia, ...	26	1.05	-	21.68	19.59	22.16	-	-	-	-	-	-	-	-	-	-	-	-	-	60.00	-	-	-
Phosphate of ammonia, ...	1	6.05	-	-	-	10.37	-	-	-	-	-	48.86	-	-	-	-	-	-	-	12.46	-	-	.82
Sulphate of soda, ...	1	1.38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	59.43	-	-	-
Saltpetre waste, ...	12	2.54	-	3.30	.52	2.22	30.94	1.55	13.66	-	-	-	-	-	-	37.04	.75	.19	-	1.86	-	46.25	-

Nitre salt-cake, ...	2	6.08	-	-	-	2.29	-	-	.87	-	-	-	-	-	-	29.56	-	-	-	47.77	-	-	3.92
Wood ashes, ...	392	10.80	-	-	-	-	10.80	1.20	5.34	5.58	.05	1.55	-	-	-	-	33.46	3.31	.96	-	-	-	14.12
Cotton-seed-hull ashes, ...	44	8.25	-	-	-	-	42.12	9.91	22.54	13.67	2.89	8.35	-	-	-	-	9.33	10.47	1.71	-	-	-	13.32
Ashes of spent tan-bark, ...	5	4.84	-	-	-	-	2.87	.60	1.81	2.77	.13	1.38	-	-	-	-	31.11	3.39	1.78	-	-	-	25.21
Corn-cob ashes, ...	1	1.20	-	-	-	-	-	-	7.08	-	-	2.37	-	-	-	-	11.70	-	1.28	-	-	-	52.09
Railroad-tie ashes, ...	1	4.70	-	-	-	-	-	-	.92	-	-	.56	-	-	-	-	2.51	-	-	-	-	-	80.20
Peat ashes, ...	1	4.67	-	-	-	-	-	-	.48	-	-	.11	-	-	-	-	2.28	1.63	6.13	-	-	-	45.17
Logwood ashes, ...	1	1.50	-	-	-	-	-	-	.08	-	-	2.30	-	-	-	-	3.90	-	-	-	-	-	9.70
Hard-pine wood ashes, ...	1	.75	-	-	-	-	-	-	10.16	-	-	2.24	-	-	-	-	24.95	-	-	-	-	-	29.90
Mill ashes, ...	1	.53	-	-	-	-	-	-	1.60	-	-	.48	-	-	-	-	34.93	1.35	-	-	-	-	36.36
Ashes from cremation of swill, ...	11	5.93	-	-	-	-	8.83	1.25	3.98	32.36	16.61	16.07	-	-	-	-	33.58	1.87	4.65	-	-	-	17.74
Ashes from blue works, ...	1	12.14	63.78	-	-	-	-	-	9.02	-	-	-	-	-	-	-	-	-	-	-	-	-	12.30
Sea-weed ashes, ...	1	1.47	-	-	-	-	-	-	.92	-	-	.30	-	-	-	8.76	6.06	4.37	-	2.98	-	6.60	63.65
Gypsum, ...	8	13.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	32.86	-	-	48.01	-	-	.59
Gypse, ...	1	1.64	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50.87	-	-	-	-	-	2.87
Nova Scotia plaster, ...	10	6.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33.85	.75	-	45.75	-	-	2.50
Onondaga plaster, ...	4	13.27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30.00	4.66	-	32.50	8.20	-	9.83
Lime, ...	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	96.10	-	-	-	-	-	1.33
Waste lime, ...	1	.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	74.12	-	-	-	-	-	.38
Gas-house lime, ...	8	22.28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	43.66	8.30	-	20.73	-	-	6.05
Lime waste from sugar factory, ...	1	36.30	-	-	-	-	-	-	.22	-	-	2.25	-	-	-	-	27.51	-	-	-	-	-	.32
Lime-kiln ashes, ...	14	15.46	-	-	-	-	2.12	.02	1.15	3.16	.36	1.23	-	-	-	-	41.99	2.60	-	-	17.75	-	7.87

	Analyses.	Moisture.	Ash.	NITROGEN.			POTASH.			TOTAL PHOSPHORIC ACID.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
I. Chemicals, Refuse, Salts, Ashes, etc. — Concluded.																							
Marls (Massachusetts), ...	7	13.70	-	-	-	-	-	-	.24	2.72	.06	1.05	-	-	-	-	40.50	.64	.69	-	28.57	-	3.44
Marls (Virginia), ...	2	15.98	-	-	-	-	.61	.37	.49	.09	.08	.09	-	-	-	-	7.25	.21	-	.66	7.25	-	64.23
Green sand marl (Virginia), ...	1	1.25	-	-	-	-	-	-	1.14	-	-	9.37	-	-	-	-	25.78	-	5.13	-	-	-	41.32
Olive earth (Virginia), ...	1	1.97	-	-	-	-	-	-	.24	-	-	13.73	-	-	-	-	19.16	-	6.00	-	-	-	50.55
Ammoniated marl, ...	1	3.31	-	-	-	1.61	-	-	-	-	-	10.39	-	.41	9.98	-	-	-	-	-	-	-	-
Marl (North Carolina), ...	1	1.50	-	-	-	-	-	-	.04	-	-	.56	-	-	-	-	21.95	.61	-	-	-	-	50.18
Clay (so called), ...	1	.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	54.35	1.04	2.80	-	37.32	-	2.57.
II. Guanos, Phosphates, etc.																							
Peruvian guano, ...	26	14.81	37.61	13.50	4.44	7.85	4.08	1.14	2.61	20.60	5.96	15.26	4.57	3.79	6.90	-	-	-	-	-	-	-	6.60
Bat guano from Texas, ...	9	40.09	18.24	10.51	2.58	6.47	-	-	1.31	6.53	1.00	3.78	-	-	-	-	-	-	-	-	-	-	2.00
Bat guano from Florida, ...	2	15.66	-	-	-	9.74	-	-	1.77	3.44	3.26	3.35	-	-	-	-	-	-	-	-	-	-	19.33
Rat guano from Florida, ...	1	10.32	-	-	-	3.32	-	-	6.85	-	-	2.30	-	-	-	-	-	-	-	-	-	-	1.15
Cuban guano, ...	5	24.27	-	2.74	.63	1.67	-	-	-	16.16	11.54	13.35	-	-	-	-	-	-	-	-	-	-	3.17
Caribbean guano (orchilla), ...	12	7.31	-	-	-	-	-	-	-	35.43	18.11	26.77	-	-	-	-	39.95	3.29	-	2.66	-	-	1.27

Mona Island guano,	1	13.32	-	-	-	.78	-	-	-	-	-	21.88	-	7.55	14.33	-	37.49	-	-	-	-	-	2.45
South Carolina rock phosphate,	6	1.45	-	-	-	-	-	-	-	30.51	24.70	27.47	.27	.07	27.18	-	41.87	3.03	4.80	-	-	-	9.04
South Carolina floats,	1	.83	-	-	-	-	-	-	-	-	-	23.39	-	2.83	21.06	-	-	-	-	-	-	-	20.16
Florida rock phosphate,	29	2.09	-	-	-	-	-	-	-	38.97	6.95	26.15	-	-	-	-	30.40	-	7.56	-	-	-	27.29
Soft Florida phosphate,	3	4.87	-	-	-	-	-	-	-	19.94	17.71	18.73	-	-	-	-	23.72	-	6.82	-	-	-	20.92
Navassa phosphate,	2	7.60	-	-	-	-	-	-	-	34.45	34.09	34.27	-	-	-	-	37.45	-	10.27	-	-	-	2.70
Brockville phosphate,	1	2.50	-	-	-	-	-	-	-	-	-	35.21	-	-	-	-	-	-	-	-	-	-	6.46
Phosphatic slag,	4	1.45	-	-	-	-	-	-	-	30.51	18.91	23.49	-	3.06	21.65	-	48.66	3.42	10.12	-	-	-	9.40
Odorless phosphate,	3	3.35	-	-	-	-	.52	.32	.42	19.45	18.40	18.75	-	-	-	-	52.85	-	-	-	2.51	-	5.90
Dissolved bone-black,	4	11.14	47.50	-	-	-	-	-	-	17.54	15.35	16.04	14.56	1.12	.36	-	-	-	-	-	-	-	8.46
Bone-black,	5	4.60	-	-	-	-	-	-	-	30.54	16.56	28.28	-	-	-	-	-	-	-	-	-	-	3.64
Double superphosphate,	1	5.74	-	-	-	-	-	-	-	-	-	47.80	38.38	9.04	.38	-	16.00	-	-	1.19	-	-	.60
South American bone-ash,	1	7.00	-	-	-	-	-	-	-	-	-	35.89	-	-	-	-	44.89	-	-	-	-	-	4.50
Acid phosphate,	1	14.23	69.95	-	-	-	-	-	-	-	-	14.64	10.34	2.42	1.88	-	-	-	-	-	-	-	10.81
III. Refuse Substances.																							
Dried blood,	16	12.23	6.37	13.55	8.10	10.51	-	-	-	6.23	1.53	2.05	-	-	-	-	-	-	-	-	-	-	-
Ammonite,	1	5.88	-	-	-	11.33	-	-	-	-	-	3.43	-	-	-	-	-	-	-	-	-	-	1.38
Oleomargarine refuse,	1	8.54	14.42	-	-	12.12	-	-	-	-	-	.88	-	-	-	-	-	-	-	-	-	-	.96
Felt refuse,	1	29.24	33.53	-	-	5.26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sponge refuse,	1	7.25	-	-	-	2.43	-	-	-	-	-	3.19	-	-	-	-	3.94	1.27	-	-	-	-	39.05

	Analyses.	Moisture.	Ash.	NITROGEN.			POTASH.			TOTAL PHOSPHORIC ACID.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
III. Refuse Substances—Continued.																							
Horn shavings, ...	1	4.83	-	-	-	15.31	-	-	-	-	-	.42	-	-	-	-	-	-	-	-	-	-	-
Ivory dust, ...	1	11.50	52.63	-	-	6.64	-	-	-	-	-	24.56	.97	17.97	5.62	-	-	-	-	-	-	-	-
Horn and hoof waste, ...	3	10.17	7.63	15.49	11.84	13.25	-	-	-	2.30	1.36	1.83	-	-	-	-	-	-	-	-	-	-	.24
Raw wool, ...	1	6.95	7.54	-	-	12.88	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.63
Wool waste, ...	9	12.90	24.10	10.20	.96	4.88	3.50	.06	1.46	.67	.05	.35	-	-	-	-	.11	.06	.80	-	-	-	8.20
Wool washings (water), ...	1	-	-	-	-	-	-	-	3.92	-	-	-	-	-	-	.49	.28	-	-	-	-	-	-
Wool washings (acid), ...	1	-	-	-	-	-	-	-	4.20	-	-	-	-	-	-	.40	.61	.20	-	-	-	-	-
Wool washings (alkaline), ...	1	92.03	3.28	-	-	.09	-	-	1.09	-	-	-	-	-	-	.92	.04	-	-	-	-	-	.22
Meat mass, ...	5	12.09	13.60	11.50	9.69	10.44	-	-	-	3.58	.56	2.07	-	-	-	-	-	-	-	-	-	-	.58
Bone soup, ...	1	82.92	7.07	-	-	1.14	-	-	-	-	-	1.26	-	-	-	-	-	-	-	-	-	-	-
Dried soup from meat and bone, . .	1	14.80	8.40	-	-	9.97	-	-	-	-	-	.53	-	-	-	-	-	-	-	-	-	-	.64
Dried soup from rendering cattle feet, .	1	10.80	7.50	-	-	14.47	-	-	-	-	-	.46	-	-	-	-	-	-	-	-	-	-	.26
Dried soup from horse rendering, . .	1	92.14	-	-	-	1.12	-	-	-	-	-	.14	-	-	-	-	-	-	-	-	-	-	-
Soap-grease refuse, ...	2	29.25	51.39	4.20	2.21	3.21	-	-	-	15.37	11.04	13.21	-	-	-	-	-	-	-	-	-	-	1.29
Bones, ...	156	7.00	58.08	4.70	1.57	3.96	-	-	-	32.52	15.10	22.29	.38	8.24	13.62	-	-	-	-	-	-	-	1.09

Meat and bone, ...	1	5.70	-	-	-	4.01	-	-	-	-	-	21.88	.26	8.32	13.30	-	-	-	-	-	-	-	-
Tankage, ...	6	9.84	-	9.16	6.94	8.14	-	-	-	12.60	4.03	10.20	-	-	-	-	-	-	-	-	-	-	-
Fish with less than twenty per cent. water,	67	12.45	21.50	11.40	5.97	7.45	-	-	-	15.91	5.50	8.46	.55	2.64	5.06	-	-	-	-	-	-	-	2.01
Fish with between twenty and forty per cent. water, ...	10	30.19	20.59	7.41	4.22	5.97	-	-	-	8.32	4.68	7.09	.74	2.69	3.64	-	-	-	-	-	-	-	1.68
Fish with more than forty per cent. water,	10	45.46	15.50	7.60	2.43	4.97	-	-	-	8.56	2.94	5.08	1.17	1.33	2.58	-	-	-	-	-	-	-	1.35
Whale meat, raw, ...	1	44.50	1.04	-	-	4.86	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lobster shells, ...	1	7.27	-	-	-	4.50	-	-	-	-	-	3.52	-	-	-	-	22.24	1.30	-	-	-	-	.27
Castor-bean pomace, ...	6	9.68	5.70	5.72	5.22	5.51	3.40	.64	1.57	2.26	1.57	2.18	-	-	-	-	.87	.29	-	-	-	-	1.75
Cotton-seed meal, ...	28	6.53	5.78	7.70	4.02	8.67	2.38	.48	1.71	3.36	.73	1.59	-	-	-	-	-	-	-	-	-	-	.33
Rotten brewers' grain, ...	1	78.77	-	-	-	.72	-	-	.04	-	-	.43	-	-	-	-	.26	.15	-	-	-	-	.59
Mill sweepings, ...	1	9.49	-	-	-	3.78	-	-	.66	-	-	1.18	-	-	-	-	-	-	-	-	-	-	5.01
Tobacco leaf, ...	1	13.05	21.01	-	-	2.75	-	-	7.24	-	-	.43	-	-	-	-	4.17	2.17	.32	-	-	-	4.17
Tobacco stems, ...	6	10.61	14.07	2.91	.90	2.29	8.82	8.76	8.44	2.09	.44	.60	-	-	-	.34	8.89	1.23	-	-	-	-	.82
Cotton waste, wet, ...	1	34.69	-	-	-	1.30	-	-	.80	-	-	1.54	-	-	-	-	2.45	1.13	-	-	-	-	41.33
Cotton waste, dry, ...	1	6.44	60.60	9.83	.96	3.45	1.62	.66	1.20	1.80	.26	.73	-	-	-	-	-	-	-	-	-	-	45.00
Refuse from calico works, ...	1	4.07	-	-	-	4.28	-	-	-	-	-	11.95	-	-	-	-	-	-	-	-	-	-	-
Cotton dust, ...	1	34.46	50.93	-	-	.50	-	-	.19	-	-	.21	-	-	-	-	.90	.90	-	-	-	-	47.46
Glucose refuse, ...	1	8.10	-	-	-	2.62	-	-	.15	-	-	.29	-	-	-	-	.18	.02	-	-	-	-	.07
Waste from lactate factory, ...	1	34.11	-	-	-	.68	-	-	-	-	-	.67	-	-	-	-	22.59	-	-	-	-	-	6.92
Hop refuse, ...	1	8.98	-	-	-	.98	-	-	.11	-	-	.20	-	-	-	-	.27	.10	-	-	-	-	.63
Banana skins, ...	1	13.99	-	-	-	.24	-	-	5.46	-	-	1.80	-	-	-	-	-	-	-	-	-	-	-

	Analyses.	Moisture.	Ash.	NITROGEN.			POTASH.			TOTAL PHOSPHORIC ACID.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
III. Refuse Substances—Concluded.																							
Sumac waste,	1	63.06	6.80	-	-	1.19	-	-	3.25	-	-	-	-	-	-	-	1.14	3.25	-	-	-	-	2.25
Eel-grass,	2	35.39	15.60	.96	.70	.83	1.61	.21	.91	.41	.22	.32	-	-	-	1.63	2.13	.11	-	-	-	-	1.06
Pine-barren grass,	1	8.48	2.40	-	-	.16	-	-	.07	-	-	.18	-	-	-	-	-	-	-	-	-	-	1.67
Pine needles,	1	9.48	3.42	-	-	.48	-	-	.03	-	-	.12	-	-	-	-	-	-	-	-	-	-	1.22
Rockweed, green,	1	68.50	23.70	-	-	.62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rockweed, dry,	1	10.68	35.75	-	-	1.45	-	-	4.89	-	-	2.75	-	-	-	7.90	7.66	.21	-	-	-	-	10.40
Jute waste,	1	13.10	-	-	-	1.50	-	-	.08	-	-	.72	-	-	-	-	-	-	-	-	-	-	-
Hair waste,	1	72.81	-	-	-	1.39	-	-	.32	-	-	.61	-	-	-	-	-	-	-	-	-	-	-
Starch waste from rubber factory,	1	10.01	.23	-	-	.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sludge from sewage precipitating tanks,	1	88.49	9.50	-	-	.06	-	-	.05	-	-	.10	-	-	-	-	1.58	.39	6.22	-	-	-	.93
Sludge,	1	6.28	-	-	-	.68	-	-	-	-		1.36	-	-	-	-	8.66	-	17.68	-	-	-	38.03
Residue from water filter,	1	94.22	-	-	-	.12	-	-	-	-	-	.05	-	-	-	-	-	-	-	-	-	-	-
Blue-green algæ (*Lyngbia majuscula*), dry,	1	16.26	-	-	-	4.25	-	-	.79	-	-	.19	-	-	-	3.53	2.06	1.18	-	-	-	-	5.53
Mussel mud, wet,	1	60.01	27.29	-	-	.21	-	-	6.17	-	-	.10	-	-	-	.70	.93	.14	8.48	-	-	-	-
Mussel mud, dry,	1	2.24	72.02	-	-	.72	-	-	-	-	-	.35	-	-	-	-	23.39	-	8.26	-	-	-	37.60

Salt mud,	2	58.37	41.19	.40	.39	.40	.33	.32	.33	-	-	-	-	-	-	-	.94	.91	.37	4.13	-	-	-	34.88
Fresh-water mud,	1	40.37	-	-	-	1.37	-	-	.22	-	-	.26	-	-	-	-	1.27	.29	1.80	-	-	-	18.26
Muck,	21	62.19	13.75	2.54	.26	.33	-	-	-	.17	.08	.13	-	-	-	-	-	-	-	-	-	-	11.35
Peat,	10	61.50	8.20	1.40	.41	.35	-	-	.18	-	-	.08	-	-	-	-	.52	.72	2.14	-	-	-	2.20
Peat,	1	10.73	17.26	-	-	1.73	-	-	.06	-	-	.03	-	-	-	-	-	-	-	-	-	-	10.14
Turf,	2	19.29	6.36	1.97	1.91	1.94	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Soot,	6	1.87	77.10	1.05	.09	.41	1.83	.21	.64	2.10	.19	1.06	-	-	-	-	3.11	-	7.19	-	-	-	67.25
Boiler soot,	1	18.80	-	-	-	-	-	-	.26	-	-	.70	-	-	-	-	58.28	1.46	1.46	-	32.95	-	3.09
IV. Animal Excrement, etc.																							
Barn-yard manure,	64	66.62	-	1.36	.21	.54	1.40	.13	.54	.75	.10	.40	-	-	-	-	.30	.19	-	-	-	-	8.48
Horse manure,	1	11.24	-	-	-	.74	-	-	2.82	-	-	1.48	-	-	-	-	-	-	-	-	-	-	12.60
Sheep manure,	1	64.88	-	-	-	.686	-	-	.525	-	-	.425	-	-	-	-	-	-	-	-	-	-	.404
Drainage from a manure heap,	1	93.20	3.66	-	-	.98	-	-	.88	-	-	.24	-	-	-	-	-	-	-	-	-	-	-
Poudrette, dry,	1	5.25	35.45	-	-	3.58	-	-	.49	-	-	5.74	-	-	-	-	-	-	-	-	-	-	4.65
Goose manure,	1	48.92	-	-	-	.21	-	-	.81	-	-	.95	-	-	-	-	-	-	-	-	-	-	-
Hen manure, fresh,	2	52.35	24.75	1.20	.79	.99	.32	.18	.25	1.00	.47	.74	-	-	-	-	1.19	.89	-	1.24	-	-	23.50
Hen manure, dry,	1	8.35	-	-	-	2.13	-	-	3.94	-	-	2.02	-	-	-	-	2.22	.62	-	-	-	-	34.64
Hen-house refuse,	1	3.43	-	-	-	.98	-	-	.60	-	-	1.28	-	-	-	-	-	-	-	-	-	-	-

V. COMPILATION OF ANALYSES OF FODDER ARTICLES, FRUITS, SUGAR-PRODUCING PLANTS, DAIRY PRODUCTS, ETC.,

MADE AT

AMHERST, MASS.

1868-1895.

PREPARED BY C. S. CROCKER.

A. ANALYSES OF FODDER ARTICLES.
B. ANALYSES OF FODDER ARTICLES WITH REFERENCE TO FERTILIZING INGREDIENTS.
C. ANALYSES OF FRUIT.
D. ANALYSES OF SUGAR-PRODUCING PLANTS.
E. DAIRY PRODUCTS.
F. INSECTICIDES.

A. *Analyses of Fodder Articles.*

NAME.	Analyses.	DRY MATTER.			ONE HUNDRED PARTS OF DRY MATTER CONTAIN —													Ash.
					PROTEIN.			FAT.			NITROGEN-FREE EXTRACT.			FIBRE.				
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.		
I. Green Fodders.																		
Fodder corn,	31	31.47	10.33	20.29	17.19	6.05	9.86	6.10	1.42	2.44	63.13	42.02	56.51	31.53	18.27	25.29		5.90
Fodder corn ensilage,	38	37.43	13.12	21.70	16.72	5.98	8.66	6.49	1.82	3.80	65.69	42.99	54.28	38.92	17.67	27.73		5.33
Corn and soja-bean ensilage,	3	28.97	19.67	23.55	15.27	7.91	10.53	5.35	3.02	4.04	52.24	40.50	43.47	37.84	26.62	31.15		10.81
Oat and pea ensilage,	1	-	-	61.98	-	-	13.72	-	-	3.94	-	-	41.81	-	-	31.34		9.19
Millet and bean ensilage,	1	-	-	24.18	-	-	10.64	-	-	5.40	-	-	42.44	-	-	31.23		10.29
Ensilage of millet and white soja bean,	1	-	-	22.59	-	-	11.25	-	-	3.71	-	-	42.99	-	-	33.14		8.91
Ensilage of *Panicum miliaceum*,	1	-	-	21.99	-	-	7.46	-	-	3.34	-	-	49.08	-	-	31.80		8.32
Ensilage of *Panicum crus-galli*,	1	-	-	23.25	-	-	7.89	-	-	2.74	-	-	43.87	-	-	36.93		8.57
Sorghum,	6	23.18	12.38	17.41	11.84	7.46	8.74	2.00	1.21	1.55	64.93	47.65	56.15	29.27	22.00	26.73		6.83
Common millet,	9	42.29	21.32	35.42	12.16	5.43	7.50	3.99	2.09	2.74	58.61	46.39	53.93	33.98	24.88	30.99		4.84
Japanese millet (white head),	3	26.24	20.95	24.76	10.98	7.26	8.72	2.64	1.94	2.33	50.87	46.71	49.60	38.90	30.12	34.47		4.88
Japanese millet (red head),	6	33.83	22.66	27.33	7.99	4.92	6.90	2.45	1.58	2.01	60.83	50.11	52.91	35.29	25.21	32.10		6.08
Panicum miliaceum,	1	-	-	30.63	-	-	5.96	-	-	3.84	-	-	58.82	-	-	26.85		5.53
Panicum crus-galli,	2	29.28	24.89	27.08	11.45	7.98	9.71	2.79	2.20	2.49	57.88	46.50	52.20	29.51	26.31	27.91		7.69
White kibi,	2	24.26	22.85	23.56	15.14	10.79	12.97	1.61	1.50	1.56	53.66	52.30	47.29	35.29	25.21	32.10		6.08
Mochi millet,	3	42.29	30.07	37.42	11.90	6.11	9.94	1.94	1.74	1.81	67.08	49.06	55.69	29.80	20.01	25.56		7.00
Green oats,	6	55.69	15.51	25.97	20.47	7.05	13.91	3.95	2.02	2.89	50.69	40.42	44.91	33.12	25.20	30.04		8.25

Green rye,	2	37.89	98.05	27.97	9.64	5.38	7.51	2.46	1.86	2.16	65.37	40.20	52.79	42.17	21.52	31.84	5.70
Green barley,	1	-	-	20.89	-	-	13.16	-	-	2.91	-	-	37.48	-	-	37.72	8.73
Timothy (*Phleum pratense*),	2	35.00	34.26	34.63	8.83	8.20	8.52	2.07	1.95	2.01	51.33	51.23	51.27	33.28	32.50	32.87	5.38
Hungarian grass (*Setaria Italica* Beauv.),	2	25.93	25.69	25.81	9.39	9.38	9.38	2.43	1.01	1.72	57.80	48.01	52.92	31.23	24.66	27.94	8.04
Vetch and oats (one part vetch and four parts oats),	1	-	-	20.84	-	-	13.27	-	-	3.90	-	-	43.69	-	-	30.34	8.80
Vetch and oats (one part vetch and nine parts oats),	3	24.04	13.89	18.97	10.76	8.83	10.06	2.74	2.29	2.53	49.85	40.10	44.75	35.81	30.77	33.59	9.07
Vetch and oats (equal parts of each),	1	-	-	17.98	-	-	18.77	-	-	2.79	-	-	41.33	-	-	29.80	9.31
Barley and peas,	1	-	-	16.09	-	-	13.40	-	-	3.00	-	-	41.79	-	-	33.40	8.32
Oats and peas,	2	18.41	13.68	16.04	16.01	14.17	15.09	3.40	2.29	2.84	48.14	40.56	44.36	32.20	26.66	29.43	8.28
Horse bean (*Vicia faba* L.),	1	-	-	15.17	-	-	16.68	-	-	2.31	-	-	47.09	-	-	28.17	5.75
Flat pea (*Lathyrus sylvestris*),	2	21.38	21.20	21.29	30.65	27.26	28.95	5.00	3.29	4.14	35.06	31.83	33.46	28.27	20.38	24.32	9.13
Soja bean (*Soja hispida*),	14	36.36	18.54	24.48	22.19	13.71	17.26	8.98	2.71	4.57	47.89	34.24	41.73	31.89	21.67	26.47	9.97
Soja bean (early white),	4	34.02	20.49	28.24	20.13	13.81	16.48	2.97	2.16	2.71	49.94	37.23	45.27	27.12	17.28	22.76	12.78
Soja bean (early green),	1	-	-	30.16	-	-	19.35	-	-	3.87	-	-	40.30	-	-	23.51	12.97
Soja bean (early black),	1	-	-	17.79	-	-	16.18	-	-	3.38	-	-	42.52	-	-	25.06	12.86
Soja bean (medium black),	1	-	-	23.13	-	-	21.67	-	-	6.76	-	-	37.18	-	-	21.73	12.66
Soja bean (late),	4	31.89	20.22	26.02	27.49	18.56	22.84	3.34	2.25	2.76	44.84	37.97	39.70	23.62	16.47	21.09	13.61
Bokhara clover (*Melilotus alba* Desr.),	3	24.14	19.01	21.22	23.37	17.18	19.72	3.51	2.76	3.04	38.43	37.02	37.89	33.99	24.43	29.46	9.89
Kidney vetch (*Anthyllis vulneraria*),	1	-	-	19.15	-	-	18.43	-	-	3.51	-	-	49.84	-	-	14.94	13.28
Serradella (*Ornithopus sativus* Brot.),	3	19.42	15.40	17.59	17.75	12.17	15.01	2.65	2.09	2.41	46.41	35.45	41.51	38.76	26.21	30.08	10.99
Prickly comfrey (*Symphytum officinale*),	1	-	-	13.21	-	-	17.49	-	-	2.06	-	-	46.30	-	-	11.03	21.12
White lupine (*Lupinus albus*),	1	-	-	14.65	-	-	18.71	-	-	2.41	-	-	42.67	-	-	31.18	5.03

A. *Analyses of Fodder Articles* — Continued.

NAME.	Analyses.	DRY MATTER.			ONE HUNDRED PARTS OF DRY MATTER CONTAIN —												
					PROTEIN.			FAT.			NITROGEN-FREE EXTRACT.			FIBRE.			Ash.
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	
I. Green Fodders — Concluded.																	
Yellow lupine (*Lupinus luteus*), ...	1	-	-	13.95	-	-	17.84	-	-	1.87	-	-	42.05	-	-	27.10	11.14
Spanish moss (*Tillandsia usneoides*), ...	1	-	-	89.20	-	-	4.45	-	-	2.54	-	-	57.73	-	-	32.61	2.67
II. Hay and Dry Coarse Fodders.																	
English hay (mixed hay), ...	56	91.94	66.59	85.53	14.19	6.19	9.46	4.10	1.56	2.85	54.72	43.63	50.29	35.55	26.41	31.05	6.35
Rowen of mixed hays, ...	15	91.76	75.55	82.74	14.70	11.63	12.72	5.03	2.60	3.62	53.52	41.92	49.68	31.50	24.25	26.77	7.21
Timothy hay, ...	6	92.76	81.26	89.39	9.37	7.24	8.66	2.65	1.95	2.22	54.43	50.01	51.34	36.59	29.21	32.90	4.88
Red-top hay (*Agrostis vulgaris* With.)	4	93.19	91.76	92.30	8.40	6.41	7.88	1.69	1.50	1.60	54.74	50.32	52.63	34.11	31.12	32.92	4.97
Kentucky blue-grass (*Poa pratensis* L.), ...	2	96.10	93.22	94.66	8.78	8.65	8.72	2.08	2.08	2.08	49.61	44.11	46.29	36.84	32.21	34.58	8.35
Orchard grass (*Dactylis glomerata* L.), ...	4	91.62	90.86	91.17	11.29	7.57	9.43	3.56	2.40	2.91	47.34	43.50	46.16	35.79	34.12	34.89	7.05
Meadow fescue (*Festuca pratensis* Huds.), . . .	5	94.70	87.84	91.09	7.85	5.89	6.76	2.17	1.65	1.87	49.18	42.03	46.31	39.90	34.01	36.88	8.18
Perennial rye-grass (*Lolium perenne* L.), ...	4	93.64	90.50	92.80	16.56	6.59	11.71	3.15	1.59	2.37	55.77	38.82	48.14	30.86	26.79	29.64	8.14
Italian rye-grass (*Lolium Italicum* A. Br.), . . .	4	92.62	90.70	91.54	9.75	6.20	8.15	2.07	1.39	1.85	52.80	43.09	49.14	36.90	31.27	33.34	7.52
Hungarian grass, ...	1	-	-	92.55	-	-	9.46	-	-	2.22	-	-	50.64	-	-	31.96	5.73
Barn-yard grass (*Panicum crus-galli* L.), ...	1	-	-	93.35	-	-	15.27	-	-	1.95	-	-	39.24	-	-	33.72	10.02
Hay of black grass, ...	1	-	-	91.25	-	-	6.72	-	-	3.37	-	-	49.47	-	-	31.41	9.08
Low meadow hay, ...	1	-	-	91.89	-	-	9.51	-	-	1.88	-	-	46.27	-	-	35.59	6.75
Salt hay, ...	2	91.92	90.34	91.13	4.35	3.77	4.06	3.24	2.65	2.95	60.15	60.14	60.14	27.84	27.82	27.83	5.02

Millet,	6	93.85	90.25	92.54	8.88	7.09	7.81	3.63	.89	2.05	55.80	49.62	51.74	35.91	29.80	33.32	5.08
Oats in bloom,	1	-	-	93.57	-	-	6.58	-	-	2.92	-	-	50.03	-	-	34.06	6.41
Oats in milk,	1	-	-	90.45	-	-	10.89	-	-	2.69	-	-	46.02	-	-	34.32	6.08
Oats, ripe,	1	-	-	91.30	-	-	8.05	-	-	2.61	-	-	48.92	-	-	36.31	6.11
Winter rye in bloom,	1	-	-	91.40	-	-	10.86	-	-	2.57	-	-	47.40	-	-	32.97	6.40
Barley in milk,	1	-	-	88.75	-	-	10.26	-	-	2.76	-	-	52.91	-	-	29.12	4.95
Common buckwheat,	1	-	-	91.50	-	-	17.80	-	-	3.04	-	-	45.08	-	-	19.35	14.63
Silver-hull buckwheat,	1	-	-	91.09	-	-	12.22	-	-	2.55	-	-	47.99	-	-	27.07	10.17
Japanese buckwheat,	1	-	-	94.29	-	-	10.80	-	-	2.22	-	-	38.60	-	-	36.02	12.36
Dry fodder corn,	4	93.35	90.58	92.11	9.31	6.17	7.74	2.76	1.11	1.84	58.89	53.86	55.97	38.75	23.08	29.31	5.14
Corn stover,	28	94.44	75.00	88.53	12.15	5.46	7.37	2.63	1.08	1.38	63.05	44.65	50.52	38.83	20.98	34.90	5.83
Teosinte (*Euchlæna luxurians* Dur. and Asch.),	1	-	-	93.94	-	-	9.71	-	-	1.28	-	-	53.18	-	-	28.88	6.95
Mammoth red clover (*Trifolium medium* L.),	8	92.66	82.47	88.59	18.50	14.06	15.75	2.25	1.86	2.18	48.98	46.51	44.77	33.72	20.16	27.51	9.84
Alsike clover (*Trifolium hybridum* L.),	6	93.92	86.48	90.07	17.55	14.77	16.63	3.26	1.88	2.58	46.64	38.03	42.72	32.34	21.44	28.17	11.90
Medium red clover (*Trifolium pratense* L.),	2	94.90	93.98	94.44	15.01	14.63	14.82	2.62	2.36	2.49	43.88	42.81	43.34	30.76	29.97	30.37	8.98
Lucerne (alfalfa) (*Medicago sativa* Desr.),	5	95.40	84.00	91.40	16.34	11.12	14.22	2.50	1.04	1.65	51.62	40.25	46.20	34.39	25.42	29.72	8.11
Sand lucerne (*Medicago media* Pers.),	1	-	-	91.20	-	-	16.26	-	-	2.59	-	-	50.31	-	-	21.27	9.57
Bokhara clover (*Melilotus alba* Desr.),	5	93.64	91.50	92.09	23.37	11.81	17.18	4.79	1.85	3.15	51.36	37.02	40.79	33.05	28.08	29.90	8.93
Blue melilot (*Melilotus cærulea* Desr.),	1	-	-	91.78	-	-	13.81	-	-	1.67	-	-	42.48	-	-	27.17	14.87
Sainfoin (*Onobrychis sativa*),	8	91.28	87.83	90.11	18.11	15.95	17.25	4.49	2.78	3.36	50.55	42.32	46.66	26.95	22.49	24.02	8.71
Sulla (*Hedysarum coronarium*),	2	91.68	89.59	90.61	17.03	16.90	16.97	3.16	2.39	2.78	58.66	41.89	50.26	28.95	12.38	20.67	9.32
Hairy lotus (*Lotus villosus* Thuill.),	2	89.32	87.64	88.48	16.12	13.49	14.81	3.00	2.69	2.85	57.82	50.80	54.29	24.48	15.07	19.78	8.27
Summer rape (*Brassica napus*),	1	-	-	88.87	-	-	14.43	-	-	3.79	-	-	45.38	-	-	18.15	18.25

A. *Analyses of Fodder Articles* — Continued.

NAME.	Analyses.	DRY MATTER.			ONE HUNDRED PARTS OF DRY MATTER CONTAIN—												
					PROTEIN.			FAT.			NITROGEN-FREE EXTRACT.			FIBRE.			Ash.
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	
II. Hay and Dry Coarse Fodders—Concluded.																	
Winter rape (*Brassica napus*),	1	-	-	89.85	-	-	15.16	-	-	3.06	-	-	47.08	-	-	12.26	22.44
Dwarf Essex rape (*Brassica napus*),	1	-	-	92.29	-	-	12.86	-	-	3.80	-	-	48.27	-	-	18.96	16.11
Soja bean,	4	93.88	79.91	87.78	19.06	14.89	16.23	8.33	2.55	4.72	51.28	41.09	46.70	27.78	20.76	24.02	8.33
Cow-pea,	3	90.70	90.25	90.43	17.17	16.95	17.05	4.49	3.81	4.06	51.41	46.06	47.93	23.58	19.06	21.67	9.29
Small pea (*Lathyrus sativus*),	1	-	-	94.20	-	-	16.57	-	-	1.49	-	-	42.76	-	-	32.88	6.30
Flat pea (*Lathyrus sylvestris*),	1	-	-	91.10	-	-	24.04	-	-	1.78	-	-	33.03	-	-	31.78	9.39
Serradella,	3	92.80	87.23	90.44	17.97	15.26	17.03	2.91	2.37	2.55	50.22	44.49	48.18	25.92	24.37	25.15	7.09
Hairy vetch (*Vicia villosa* Roth.),	1	-	-	92.56	-	-	19.58	-	-	1.22	-	-	38.95	-	-	31.88	8.37
Common vetch (*Vicia sativa* L.),	2	91.65	90.55	91.10	15.76	14.42	15.09	2.69	2.30	2.50	44.34	43.29	43.80	30.68	30.05	30.37	8.24
Scotch tares,	1	-	-	84.20	-	-	22.00	-	-	1.89	-	-	31.46	-	-	30.89	13.76
Vetch and oats,	3	94.22	83.33	88.35	13.51	7.70	9.64	3.45	2.53	3.11	49.95	41.51	46.83	36.22	30.15	32.70	7.72
Vetch and oats (equal parts of each),	2	90.65	90.64	90.64	18.88	15.16	17.02	3.13	2.63	2.88	42.24	38.57	40.41	31.28	29.83	30.55	9.14
Vetch and barley,	2	91.51	90.76	91.13	14.44	13.36	13.90	2.56	2.12	2.34	46.55	43.70	45.13	32.58	32.25	32.41	6.22
Vetch, oats and horse bean,	1	-	-	89.81	-	-	18.93	-	-	2.70	-	-	37.94	-	-	30.07	10.36
Horse-bean straw,	1	-	-	90.85	-	-	9.89	-	-	1.51	-	-	37.77	-	-	41.44	9.39
Soja-bean straw,	3	92.37	86.03	88.57	5.73	5.34	5.48	3.49	1.17	2.15	43.72	41.02	42.81	46.51	36.80	42.38	7.18
White daisy (*Chrysanthemum leucanthemum* L.),	1	-	-	90.35	-	-	7.68	-	-	2.32	-	-	46.86	-	-	36.09	7.05

Dry carrot tops,	1	-	-	90.24	-	-	20.12	-	-	2.61	-	-	50.39	-	-	13.61	13.87
Wheat straw,	1	-	-	93.80	-	-	7.20	-	-	1.63	-	-	50.46	-	-	35.91	4.80
Barley straw,	2	91.41	88.56	89.98	9.24	6.21	7.72	3.38	2.49	2.93	48.23	46.52	46.89	39.84	33.85	36.84	5.62
Japanese millet (white head),	1	-	-	91.46	-	-	7.67	-	-	2.41	-	-	49.87	-	-	34.99	5.06
Japanese millet (red head),	1	-	-	91.13	-	-	5.76	-	-	1.70	-	-	49.66	-	-	39.52	8.36
Millet straw,	1	-	-	86.55	-	-	4.95	-	-	1.43	-	-	44.96	-	-	41.82	6.84
Straw (*Panicum crus-galli*),	1	-	-	87.35	-	-	6.10	-	-	2.44	-	-	50.20	-	-	35.90	5.36
Straw (*P. miliaceum*),	1	-	-	87.83	-	-	3.94	-	-	3.01	-	-	44.72	-	-	42.16	6.17
Straw (*P. Balicum*),	1	-	-	80.28	-	-	4.17	-	-	1.59	-	-	48.39	-	-	41.54	6.31
III. Roots, Bulbs, Tubers, etc.																	
Beets, red,	7	14.51	9.75	12.17	15.40	7.82	12.29	1.76	.59	.94	79.33	66.87	72.19	7.56	4.29	6.00	8.58
Beets, sugar,	12	19.53	9.87	14.60	17.44	7.32	11.18	.83	.58	.67	81.50	61.93	75.62	9.69	4.82	6.55	5.98
Beets, yellow fodder,	4	15.01	9.40	11.46	13.96	9.29	11.69	2.02	.84	1.39	75.22	61.90	69.33	9.66	7.26	8.14	9.45
Mangolds,	4	13.08	11.49	12.06	12.84	7.04	9.54	1.14	.73	.97	73.38	70.82	71.03	9.98	7.08	8.45	10.01
Ruta-bagas,	3	12.77	8.25	10.88	11.46	10.34	11.01	2.32	1.23	1.53	68.58	62.27	65.88	13.12	11.03	11.83	9.75
Turnips,	5	12.80	8.22	10.38	11.39	9.67	10.57	2.23	1.42	1.79	70.62	65.91	67.51	13.84	10.12	11.68	8.45
Carrots,	5	12.52	9.95	10.98	9.75	7.29	8.76	3.94	1.41	2.09	73.96	67.24	71.63	10.76	7.55	9.08	8.44
Parsnips,	1	-	-	19.66	-	-	6.88	-	-	3.37	-	-	74.65	-	-	7.67	7.43
Potatoes,	13	21.95	13.91	19.01	13.56	6.24	10.05	.83	.17	.49	87.56	78.80	*81.69	3.55	1.91	2.64	5.18
Artichokes,	1	-	-	22.51	-	-	12.82	-	-	.95	-	-	77.26	-	-	4.18	4.79
Japanese radish (*merinia*),	1	-	-	8.74	-	-	7.47	-	-	1.05	-	-	70.89	-	-	10.27	10.32
Japanese radish (*niyas hige*),	1	-	-	7.42	-	-	6.51	-	-	.96	-	-	72.87	-	-	9.79	9.87

* Starch (six determinations), 69.95 per cent.

A. Analyses of Fodder Articles — Continued.

NAME.	Analyses.	Dry Matter.			One Hundred Parts of Dry Matter contain —												
					Protein.			Fat.			Nitrogen-free Extract.			Fibre.			Ash.
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	
IV. Grains, Seeds, Fruits, etc.																	
Corn kernels,	29	91.98	65.50	89.43	15.02	8.49	12.18	9.43	4.25	5.42	83.98	71.06	78.49	3.38	1.03	2.12	1.69
Sweet corn kernels,	1	-	-	88.02	-	-	12.57	-	-	9.56	-	-	73.83	-	-	2.41	1.63
Wheat kernels,	1	-	-	89.42	-	-	13.35	-	-	1.79	-	-	80.26	-	-	2.42	2.18
Oat kernels,	1	-	-	86.84	-	-	14.44	-	-	6.83	-	-	66.21	-	-	9.03	3.49
Broom-corn seed,	1	-	-	85.90	-	-	11.21	-	-	4.05	-	-	74.05	-	-	8.34	2.35
Soja beans,	3	94.15	80.73	85.83	35.98	32.58	33.97	21.89	18.42	20.19	34.88	32.87	33.98	7.57	5.15	6.02	5.84
Horse beans,	1	-	-	89.72	-	-	30.03	-	-	1.11	-	-	56.48	-	-	8.11	4.27
Red adzinki beans,	2	85.18	83.10	84.14	25.14	23.75	24.45	.88	.76	.82	66.48	65.41	65.95	4.68	4.50	4.59	4.19
Saddle beans,	1	-	-	87.62	-	-	15.12	-	-	16.58	-	-	57.34	-	-	4.75	6.21
Daidzu beans,	1	-	-	88.47	-	-	38.99	-	-	18.59	-	-	30.41	-	-	4.97	7.04
Millet seed,	3	87.32	86.11	86.65	14.60	11.76	13.24	4.94	3.53	4.32	73.19	66.94	70.56	10.23	6.48	8.88	3.00
Chestnuts,	1	-	-	55.14	-	-	13.32	-	-	14.46	-	-	67.05	-	-	2.45	2.72
Cranberries,	1	-	-	10.59	-	-	4.40	-	-	5.61	-	-	76.37	-	-	11.63	1.99
Apples,	2	24.83	19.68	22.26	4.57	3.92	4.25	2.81	1.71	2.26	86.21	83.44	84.81	7.05	6.14	6.60	2.08
V. Flour and Meal.																	
Corn meal,	36	89.95	79.81	86.24	16.08	9.73	11.04	5.14	3.10	3.86	83.61	73.20	81.38	3.60	1.20	2.15	1.57
Corn and cob meal,	37	94.00	80.89	89.47	15.06	7.82	10.01	5.27	3.36	4.19	81.41	70.13	76.62	10.41	5.63	7.54	1.64

Cooked feed (oats and corn),	1	-	-	94.45	-	-	14.75	-	-	5.34	-	-	67.14	-	-	8.73	4.04
Hominy meal,	4	-	-	90.00	4.15	3.00	3.57	.67	.38	.57	63.62	60.58	61.72	33.77	31.36	32.93	1.21
Ground oats,	2	91.11	90.29	90.70	13.20	11.93	12.56	4.52	3.51	4.01	-	-	70.21	-	-	9.29	3.98
Ground barley,	5	89.09	82.59	86.91	14.93	9.99	12.95	2.57	1.69	2.18	78.25	74.47	76.63	8.03	4.10	6.47	2.77
Broom-corn meal,	1	-	-	86.46	-	-	11.14	-	-	4.13	-	-	74.30	-	-	8.00	2.43
Pea meal,	1	-	-	91.15	-	-	20.95	-	-	1.67	-	-	55.02	-	-	19.42	2.94
Peanut meal,	1	-	-	92.00	-	-	53.26	-	-	11.69	-	-	27.00	-	-	3.76	4.29
Bean meal,	1	-	-	88.02	-	-	12.57	-	-	9.56	-	-	73.83	-	-	2.41	1.63
Soja-bean meal,	1	-	-	89.20	-	-	41.18	-	-	18.17	-	-	30.60	-	-	5.01	5.04
Millet meal (*Panicum Italicum*),	1	-	-	89.38	-	-	35.12	-	-	17.35	-	-	38.95	-	-	3.86	4.72
VI. By-products and Refuse.																	
Linseed cake, old process,	8	92.52	88.50	90.32	39.97	33.98	36.65	9.87	6.24	7.30	44.72	37.76	40.51	9.69	8.04	8.62	6.92
Linseed cake, new process,	7	94.94	88.17	91.65	41.02	35.03	39.38	4.08	2.17	3.24	46.49	40.54	41.74	10.31	8.59	9.28	6.36
Cotton-seed meal,	32	94.42	88.81	92.11	51.79	36.54	45.24	14.72	8.41	11.68	35.84	20.22	28.11	10.83	5.08	7.44	7.51
Cotton-seed bran,	1	-	-	88.90	-	-	11.82	-	-	3.17	-	-	50.34	-	-	31.09	3.58
Wheat bran,	43	92.58	86.30	89.35	20.54	15.67	17.86	6.36	2.80	5.00	62.83	51.77	58.34	14.26	7.49	10.98	7.82
Spring-wheat bran,	8	91.03	87.26	88.67	19.54	16.19	17.78	5.46	5.37	5.41	59.39	56.54	57.50	13.75	10.84	12.02	7.29
Winter-wheat bran,	2	87.76	86.94	87.35	17.04	16.24	16.64	4.57	3.43	4.00	62.83	59.83	61.33	12.74	9.32	11.03	7.00
Wheat middlings,	7	90.75	87.57	89.76	20.07	15.13	17.19	6.46	3.19	5.40	74.30	58.03	62.46	11.21	1.40	8.46	6.49
Rye bran,	2	91.82	86.30	89.06	18.98	16.52	17.75	3.03	2.07	2.55	73.56	69.24	71.70	4.54	3.46	4.00	4.30
Rye middlings,	1	-	-	87.46	-	-	13.15	-	-	5.61	-	-	73.52	-	-	3.70	4.02
Pea bran,	1	-	-	92.86	-	-	10.31	-	-	1.16	-	-	39.04	-	-	46.16	3.33
Buckwheat middlings,	1	-	-	88.49	-	-	25.49	-	-	7.53	-	-	56.36	-	-	5.18	5.44

A. Analyses of Fodder Articles — Concluded.

NAME.	Analyses.	DRY MATTER.			ONE HUNDRED PARTS OF DRY MATTER CONTAIN —												
					PROTEIN.			FAT.			NITROGEN-FREE EXTRACT.			FIBRE.			Ash.
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	
VI. By-products and Refuse — Concluded.																	
Gluten meal,	38	93.67	68.32	90.98	39.28	25.75	29.99	14.47	3.92	9.13	66.26	48.26	56.34	10.06	.41	3.59	.95
Gluten meal (Chicago),	3	92.71	88.89	90.76	37.09	30.19	33.53	9.22	4.60	6.80	57.97	56.64	57.55	1.73	.73	1.23	.89
Gluten meal (King),	2	93.35	92.22	92.78	38.57	36.19	37.38	21.44	19.68	20.56	38.84	38.56	38.74	1.62	1.41	1.51	1.84
Gluten feed (Buffalo),	15	93.67	90.61	91.93	31.05	21.11	25.01	14.76	9.18	12.90	62.79	48.80	53.64	[illegible].06	5.43	7.42	1.03
Gluten feed (Pope),	1	-	-	86.02	-	-	38.68	-	-	16.34	-	-	42.43	-	-	1.80	.75
Gluten feed (Peoria),	2	92.93	92.50	92.71	22.71	21.35	22.03	14.33	13.62	13.97	55.27	53.50	54.39	8.86	8.30	8.58	1.03
Maize feed (Chicago),	4	91.40	90.25	91.41	29.40	21.33	25.87	7.90	6.15	7.06	62.12	53.85	57.53	9.65	7.98	8.70	.84
Starch feed (Pope),	1	-	-	94.52	-	-	11.28	-	-	11.30	-	-	61.31	-	-	15.21	.90
Dry distillery feed (Atlas mills),	1	-	-	88.75	-	-	37.30	-	-	15.28	-	-	35.07	-	-	11.94	.41
Glucose feed (Richardson),	1	-	-	93.68	-	-	23.12	-	-	11.67	-	-	52.41	-	-	11.67	1.13
Corn-germ meal,	1	-	-	90.65	-	-	28.26	-	-	11.82	-	-	42.49	-	-	9.18	8.25
Corn-germ feed,	1	-	-	92.45	-	-	10.81	-	-	12.17	-	-	62.10	-	-	14.05	.87
Corn screenings,	1	-	-	88.98	-	-	8.29	-	-	4.48	-	-	81.57	-	-	3.27	2.39
Proteina (mixed feed),	4	93.20	89.94	91.61	27.23	20.53	23.67	8.24	5.01	7.20	61.53	51.11	55.55	12.83	10.18	10.92	2.66
Excelsior feed,	1	-	-	92.92	-	-	6.75	-	-	5.42	-	-	65.75	-	-	14.65	4.43
Corn screenings,	1	-	-	88.98	-	-	8.29	-	-	4.48	-	-	81.57	-	-	3.27	2.39
Oat feed,	4	90.66	90.53	92.20	15.60	11.02	13.15	8.23	3.95	5.32	68.08	57.28	63.88	17.73	8.06	11.52	6.13
Rye feed,	2	91.77	90.37	91.05	16.62	13.65	15.09	5.04	2.79	2.91	77.51	73.88	75.44	3.02	3.52	3.58	2.96

Starch feed (Pope),	1	-	-	94.52	-	-	11.28	-	-	11.30	-	-	61.31	-	-	15.21	.90
Cocoanut meal,	1	-	-	90.67	-	-	22.61	-	-	12.88	-	-	40.03	-	-	18.80	5.68
Louisiana rice bran,	1	-	-	89.75	-	-	9.82	-	-	9.66	-	-	55.07	-	-	14.86	10.59
Peanut feed,	2	90.92	89.08	89.99	10.31	9.54	9.92	7.61	4.49	8.05	19.55	17.35	18.46	62.82	62.48	62.65	2.92
Peanut husks,	1	-	-	87.02	-	-	5.74	-	-	1.90	-	-	15.09	-	-	75.91	1.36
Bakery refuse,	1	-	-	86.66	-	-	9.23	-	-	6.36	-	-	72.34	-	-	.43	11.64
Vinegar mash,	1	-	-	5.51	-	-	16.50	-	-	8.45	-	-	63.47	-	-	8.55	3.03
Refuse from starch works,	1	-	-	42.96	-	-	22.41	-	-	10.17	-	-	58.98	-	-	7.54	.90
Oat meal and barley refuse,	1	-	-	92.24	-	-	7.45	-	-	3.80	-	-	62.61	-	-	22.30	3.84
Glucose refuse,	1	-	-	93.29	-	-	21.06	-	-	10.55	-	-	62.42	-	-	4.77	1.20
Spent brewers' grain,	4	93.02	88.00	90.13	33.16	16.08	23.29	6.29	1.95	4.89	67.62	42.32	54.04	15.90	8.07	11.25	4.53
Malt sprouts,	1	-	-	84.63	-	-	27.17	-	-	3.85	-	-	47.92	-	-	14.75	6.31
Damaged wheat,	1	-	-	86.90	-	-	16.26	-	-	2.51	-	-	75.85	-	-	3.11	2.31
Cocoa dust from cocoa manufactory,	1	-	-	92.80	-	-	15.47	-	-	25.85	-	-	45.99	-	-	5.86	6.83
Broom-corn waste,	1	-	-	91.30	-	-	6.78	-	-	1.00	-	-	48.09	-	-	39.25	4.88
Refuse from cows' manger,	4	85.73	64.81	77.44	6.63	4.34	5.01	1.09	.74	.98	45.46	42.12	43.74	46.91	38.72	43.94	6.33
Refuse from cows' manger (ensilage),	6	39.89	21.73	27.07	11.56	8.64	8.38	2.04	1.30	1.48	44.96	41.67	45.97	40.37	33.98	34.57	9.60
Cotton hulls,	3	91.85	88.55	89.98	5.36	4.10	4.79	4.27	1.79	2.81	46.75	38.59	43.34	51.40	40.24	46.08	2.98
Apple pomace,	3	21.78	12.49	17.16	7.78	5.75	6.81	5.93	3.17	4.49	72.93	63.29	69.48	21.67	13.15	17.13	2.08
Apple pomace ensilage,	1	-	-	14.67	-	-	8.22	-	-	7.36	-	-	58.03	-	-	22.18	4.21
Sugar beet pulp, from diffusion battery,	1	-	-	10.32	-	-	12.41	-	-	.95	-	-	61.86	-	-	23.74	1.04
Corn cobs,	6	94.05	90.00	92.35	4.15	1.46	2.91	.77	.38	.56	63.62	58.78	61.21	37.84	31.36	33.96	1.36
Palmetto root,	1	-	-	88.49	-	-	3.82	-	-	.53	-	-	69.95	-	-	21.26	4.44

B. *Analyses of Fodder Articles with Reference to Fertilizing Ingredients.*

NAME.	Analyses.	% Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	*Valuation per 2,000 Pounds.
I. Green Fodders.												
Fodder corn,	14	78.61	.407	4.84	.327	.048	.153	.091	.018	.148	.380	$1 93
Fodder corn ensilage,	7	80.19	.422	-	.385	.050	.100	.090	.020	.129	.255	-
Corn and soja-bean ensilage,	1	71.03	.790	-	.444	-	-	-	-	.420	-	3 67
Ensilage of millet and white soja bean,	1	77.41	.400	-	.540	-	-	-	-	.130	-	-
Ensilage of *Panicum miliaceum*,	1	78.01	.260	-	.430	-	-	-	-	.110	.500	1 49
Ensilage of *Panicum crus-galli*,	1	76.75	.294	-	.621	-	-	-	-	.133	-	1 84
Sorghum,	7	82.19	.233	-	.229	.025	.076	.075	.012	.088	.136	1 16
White kibi,	2	76.45	.489	1.22	.200	.045	.232	.148	.019	.136	.652	2 07
Mochi millet,	3	62.58	.609	2.62	.407	.120	.201	.217	.021	.188	.708	2 76
Millet (*Panicum crus-galli*),	1	75.11	.455	-	.494	-	-	-	-	.109	-	2 24
Green oats,	3	83.36	.489	1 31	.381	.217	.154	.134	.018	.130	.496	2 26
Green rye,	2	72.08	.302	-	.636	-	-	-	-	.117	-	1 87
Vetch and oats,	1	86.11	.236	1.72	.789	.031	.087	.030	.012	.094	.331	1 78
Horse bean,	1	74.71	.675	-	.946	.028	.346	.157	.050	.083	.514	2 85
Soja bean,	1	73.20	.292	-	.531	-	-	-	-	.151	-	1 76
Soja bean (early white),	1	66.56	.943	-	.905	-	-	-	-	.214	-	4 51

Soja bean (early green),	1	69.84	.835	-	.707	-	-	-	-	.201	-	3 90
Soja bean (medium black),	1	76.87	.803	-	.586	-	-	-	-	.175	-	3 61
Soja bean (late),	1	79.78	.600	-	.677	-	-	-	-	.138	-	2 98
Kidney vetch,	1	80.85	.563	-	.946	.218	.907	.055	.027	.085	.155	2 46
Cow-pea vines,	1	78.81	.274	1.47	.306	.063	.300	.099	.016	.098	.077	1 39
Prickley comfrey,	1	86.79	.370	-	.759	.122	.309	.041	.058	.115	-	2 24
Serradella,	2	82.59	.411	1.82	.420	.097	.460	.067	.021	.140	.097	2 04
Common buckwheat,	1	84.65	.440	-	.538	-	-	-	-	.089	.577	2 22
Flat pea (*Lathyrus sylvestris*),	1	78.62	1.049	-	.449	-	.302	.088	.056	.140	.247	4 30
Hungarian grass,	1	74.31	.386	-	.548	-	-	-	-	.159	-	2 11
White lupine,	1	85.35	.440	-	.253	.100	.450	.107	.025	.051	.131	1 87
Yellow lupine,	1	85.05	.398	-	.441	.086	.288	.049	.008	.092	.161	1 49
Spanish moss,	1	60.80	.279	1.04	.255	.263	.089	.122	.029	.030	.191	1 30
II. Hay and Dry Coarse Fodders.												
English hay,	10	11.94	1.294	6.34	1.528	.110	.344	.240	.021	.286	.911	6 49
Rowen,	13	18.53	1.629	9.57	1.499	.140	.640	.280	.034	.442	1.840	-
Timothy hay,	8	11.26	1.240	4.93	1.460	.180	.620	.120	.006	.342	1.000	6 28
Red-top,	4	7.71	1.150	4.59	1.020	.438	.571	.134	.036	.360	1.736	5 51
Kentucky blue-grass,	2	5.34	1.320	-	1.694	.129	.398	-	.044	.431	2.863	6 91

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* The valuation is based on the following prices per pound of the essential fertilizing ingredients: nitrogen, 17½ cents; potassium oxide, 5½ cents; phosphoric acid, 5 cents.

B. Analyses of Fodder Articles with Reference to Fertilizing Ingredients — Continued.

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	*Valuation per 2,000 Pounds.
II. Hay and Dry Coarse Fodders — Concluded.												
Orchard grass,	4	8.84	1.310	6.42	1.879	.225	.456	.297	.033	.414	2.060	$7 07
Meadow fescue,	6	8.89	.992	8.08	2.096	.301	.576	.187	.028	.399	1.537	6 18
Perennial rye-grass,	2	9.13	1.227	6.79	1.553	.307	.642	.337	.044	.559	2.262	6 56
Italian rye-grass,	4	8.71	1.189	-	1.273	.451	.857	.321	.071	.558	2.598	6 13
Salt hay,	1	5.36	1.180	-	.718	.017	.871	.335	.028	.248	-	4 46
Japanese millet (white head),	3	10.45	1.105	5.80	1.223	.012	.465	.377	.028	.403	1 033	5 62
Common buckwheat,	1	8.50	2.620	-	3.208	-	-	-	-	.532	3.436	13 04
Silver-hull buckwheat,	1	8.91	1.780	-	2.380	-	2.290	.526	.059	.860	.462	9 71
Japanese buckwheat,	1	5.72	1.629	-	3.320	.349	3.418	.421	.148	.852	.378	10 21
Fodder corn,	7	7.85	1.763	4.91	.889	175	.605	.500	.075	.542	1.270	7 69
Corn stover,	17	9.33	1.038	3.74	1.375	.112	.622	.384	.068	.288	1.782	5 43
Teosinte,	1	6.06	1.460	6.53	3.696	.109	1.597	.458	.021	.546	.315	9 72
Summer rape,	1	11.13	2.053	-	4.670	.904	3.691	.522	.031	.572	.709	12 89
Millet hay,	1	9.75	1.280	-	1.690	.020	.500	.460	.030	.490	1.300	6 83
Mammoth red clover,	3	11.41	2 231	8.72	1.223	.389	3.141	.613	.111	.548	.770	9 98

Medium red clover,	2	7.91	2.184	8.36	2.288	.210	1.689	.402	.099	.447	.919	10 61
Alsike clover,	6	9.94	2.342	11.11	2.227	.309	2.153	.537	.197	.668	1.776	11 81
Lucerne (alfalfa),	4	6.26	2.075	6.82	1.461	.814	2.211	.406	.078	.526	.518	9 40
Bokhara clover,	2	7.43	1.975	7.70	1.832	.114	1.784	.347	.023	.558	.057	9 49
Blue melilot,	1	8.22	1.919	13.65	2.798	.270	1.449	.260	.349	.544	4.008	10 84
Sainfoin,	1	12.17	2.630	7.55	2.020	.540	1.160	.430	.040	.760	.470	12 19
Sulla,	2	9.39	2.460	-	2.093	.223	2.497	.350	.114	.453	.614	11 87
Lotus villosus,	2	11.52	2.095	8.23	1.807	.499	2.220	.476	.112	.594	.976	9 91
Soja bean,	2	6.30	2.320	6.47	1.079	.148	2.760	1.178	.115	.667	.977	9 97
Cow pea,	1	9.00	1.635	8.40	.913	.122	2.696	.688	.046	.527	.832	7 25
Small pea,	1	5.80	2.497	-	1.990	.469	1.373	.276	.138	.592	1.081	11 52
Flat pea (*Lathyrus sylvestris*),	1	8.90	3.514	-	2.940	-	1.631	.454	.179	.820	1.830	15 69
Serradella,	2	7.39	2.897	10.60	.652	.656	2.545	.461	.066	.777	.590	11 97
Scotch tares,	1	15.80	2.964	-	3.004	.238	1.698	.354	.460	.815	4.062	14 49
Spring vetch,	1	8.21	2.204	-	2.760	-	1.710	-	-	.740	.510	11 48
Vetch and oats,	3	9.91	1.299	9.58	1.349	.420	.663	.265	.098	.560	.521	6 59
Soja-bean straw,	1	13.00	.714	-	1.060	-	.436	.469	.035	.259	.218	3 92
Millet straw,	1	13.45	.690	-	1.760	-	-	-	-	.180	.580	4 63
White daisy,	1	9.65	.279	6.37	1.253	.164	1.302	.191	.032	.435	1.110	2 78
Dry carrot tops,	1	9.76	3.130	12.52	4.883	4.028	2.069	.667	.118	.612	.098	16 94
Barley straw,	2	10.01	1.125	5.30	2.408	.183	.572	.180	-	.216	2.380	7 18

* See note on page 439.

B. Analyses of Fodder Articles with Reference to Fertilizing Ingredients — Continued.

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	*Valuation per 2,000 Pounds.
III. Roots, Bulbs, Tubers, etc.												
Beets, red,	8	87.82	.229	1.13	.440	.091	.049	.033	.004	.092	.020	$1 37
Beets, sugar,	4	86.95	.223	1.04	.477	.081	.057	.040	.013	.101	.048	1 40
Beets, yellow fodder,	1	90.60	.192	.95	.462	.104	.045	.030	.005	.086	.015	1 26
Mangolds,	2	87.29	.188	1.22	.383	.125	.061	.039	.005	.083	.023	1 17
Ruta-bagas,	3	89.13	.190	1.06	.489	.070	.088	.030	.004	.123	.012	1 33
Turnips,	4	89.73	.171	1.01	.379	.078	.089	.027	.009	.115	.112	1 10
Carrots,	3	89.03	.155	9.22	.461	.062	.067	.023	.009	.090	.040	1 23
Parsnips,	1	80.34	.217	-	.617	.006	.088	.045	.005	.187	.019	1 63
Potatoes,	4	80.07	.293	.99	.510	.022	.015	.035	.002	.076	.029	1 11
Artichokes,	1	77.49	.460	-	.484	-	-	-	-	.168	.039	2 31
Japanese radish (*merinia*),	1	93.26	.081	-	.281	-	-	-	-	.047	-	0 64
Japanese radish (*niyas hige*),	1	92.58	.077	-	.338	-	-	-	-	.050	-	0 79
IV. Grains.												
Corn kernels,	13	10.88	1.822	1.53	.404	.034	.032	.206	.019	.699	.020	7 52
Corn and cob meal,	29	8.96	1.409	-	.472	.059	.018	.176	.011	.571	.430	6 02

Oat kernels,	1	9.04	2.100	-	-	-	-	-	-	-	-	-
Soja beans,	2	18.33	5.303	4.99	1.991	.275	.419	.909	.216	1.869	.093	22 63
Red adzinki beans,	1	14.82	3.240	-	1.540	.035	.090	.210	.180	.940	.060	14 07
White adzinki beans,	1	16.90	3.330	-	1.480	.190	.130	.220	.021	.970	.130	14 14
Saddle beans,	1	12.38	2.120	-	2.130	.020	.250	.430	.032	1.520	.250	11 28
Daidzu beans,	1	11.53	5.520	-	1.980	.210	.220	.400	.050	1.480	.280	22 96
Japanese millet,	2	13.68	1.730	-	.380	.030	.045	.225	.015	.685	-	7 16
Common millet,	1	12.68	2.040	-	.360	.060	.040	.260	.030	.850	.143	8 38
Chestnuts,	1	44.86	1.175	2.72	.632	-	.060	.135	.010	.392	.069	5 51
Cranberries,	1	89.41	.075	-	.097	-	.018	.013	.005	.028	-	0 40
Apples,	2	79.91	.130	.41	.190	.030	.030	.030	.003	.010	.003	0 57
V. Flour and Meal.												
Corn meal,	3	14.13	1.920	1.42	.337	.064	.034	.187	.015	.714	.060	7 80
Hominy feed,	1	8.93	1.630	2.21	.490	-	.180	.280	-	.980	-	7 22
Ground barley,	1	13.43	1.550	2.06	.341	.169	.091	.173	.013	.660	.669	6 46
Wheat flour,	2	12.14	2.020	1.22	.359	-	.170	.050	-	.352	-	8 89
Pea meal,	1	8.85	3.080	2.68	.993	.618	.302	.302	.027	.820	.122	12 69
Soja-bean meal,	1	10.80	5.89	-	2.230	-	-	-	-	1.570	.280	24 64
Peanut meal,	1	8.00	7.84	-	1.540	-	-	-	-	1.270	-	-
VI. By-products and Refuse.												
Linseed meal, old process,	4	8.02	5.390	6.57	1.214	.860	.664	.763	.060	1.780	.340	21 98
Linseed meal, new process,	5	7.96	5.828	5.04	1.248	.823	.663	.655	.062	1.692	.345	24 26

* See note on page 439.

B. *Analyses of Fodder Articles with Reference to Fertilizing Ingredients* — Concluded.

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	*Valuation per 2,000 Pounds.
VI. By-products and Refuse — Concluded.												
Cotton-seed meal,	19	8.52	6.577	6.49	1.725	.291	.587	.589	.020	2.393	.322	$26 84
Wheat bran,	8	11.07	2.620	6.44	1.579	.159	.168	.899	.019	2.461	.182	13 87
Wheat middlings,	2	10.15	2.745	2.30	.750	.110	.200	.210	-	1.245	-	11 67
Rye middlings,	1	12.54	1.840	3.52	.810	.030	.090	.820	.020	1.260	.170	8 59
Rye feed,	1	9.63	1.950	-	.980	-	-	-	-	1.561	-	9 46
Gluten meal,	5	8.53	5.090	.65	.047	.018	.050	.035	.009	.420	-	18 28
Gluten feed (Buffalo),	5	8.15	3.716	-	.084	-	-	-	-	.342	.160	13 45
Gluten meal (Chicago),	1	9.33	5.380	-	.071	-	-	-	-	.380	-	-
Gluten meal (King),	1	7.78	5.690	-	.079	-	-	-	-	.690	-	-
Distillery feed (Atlas mills),	1	11.21	5.300	-	.160	-	-	-	-	.230	-	-
Spent brewers' grain,	2	8.58	2.680	6.15	.853	.347	.296	.286	.159	1.045	1.770	11 86
Proteina,	1	10.06	2.970	-	.570	-	-	-	-	1.000	-	12 02
Damaged wheat,	1	13.10	2.260	-	.505	-	-	-	-	.831	-	9 30
Louisiana rice bran,	1	10.25	1.430	-	.840	-	-	-	-	1.710	-	7 64
Glucose refuse,	1	6.71	3.370	-	.090	-	-	-	-	.610	-	12 50

Cocoa dust,	1	7.10	2.299	6.350	.630	-	.630	-	-	1.340	-	10 08
Broom-corn waste (stalks),	1	10.37	.870	4.700	1.858	-	.212	.170	-	.460	1.000	5 55
Cotton hulls,	3	10.63	.750	2.610	1.080	-	.200	.260	-	.180	.060	3 99
Peanut feed,	2	9.99	1.460	-	.790	-	-	-	-	.230	-	-
Peanut husks,	1	12.98	.800	-	.480	-	-	-	-	.130	-	-
Meat meal,	1	8.00	11.210	-	.300	-	-	-	-	.730	-	-
Apple pomace,	2	80.50	.227	.271	.134	.026	.037	.028	.008	.018	.009	0 96
Corn cobs,	8	12.09	.504	.815	.598	.071	.025	.045	.009	.063	.190	2 48
Palmetto roots,	1	11.51	.540	3.930	1.380	.345	.045	.004	.017	.157	.410	3 57
Buckwheat hulls,	1	11.90	.490	-	.521	-	.247	.236	.020	.073	.066	2 36
VII. Dairy Products.												
Buttermilk,	1	91.13	.510	.810	.046	-	.045	-	-	.041	-	1 88
Skim-milk,	22	90.30	.585	.787	-	-	-	-	-	-	-	-
Whey,	1	93.68	.102	-	.0723	-	-	-	-	.173	-	0 62

* See note on page 439.

C. Analyses of Fruits.

NAME.	Date.	Dry Matter.	Specific Gravity of Juice.	Temperature C. of Juice (Degrees).	Total Sugar in Juice.	Glucose in Juice.	Cane Sugar in Juice.	*Soda Sol. required to neutralize 100 parts Juice.
	1877.	Per ct.			Per ct.	Per ct.	Per ct.	C. C.
Apple (Baldwin), . . .	Sept. 1,	20.14	1.055	12—15	3.09	-	-	-
Apple (Baldwin), . . .	Oct. 9,	19.66	1.065	12—15	6.25	-	-	-
Apple (Baldwin), . . .	Nov. 27,	-	1.075	12—15	10.42	-	-	-
Rhode Island Greening, . .	Sept. 1,	20.27	1.055	12—15	8.16	-	-	-
Rhode Island Greening, . .	Oct. 9,	19.68	1.066	12—15	7.14	-	-	-
Rhode Island Greening,† . .	Nov. 27,	20.25	1.080	12—15	11.36	-	-	-
Pear (Bartlett), . . .	Aug. 31,	15.00	1.060	12—15	4.77	-	-	-
Pear (Bartlett), . . .	Sept. 7,	16.55	1.060	12—15	5.68	-	-	-
Pear (Bartlett), . . .	Sept. 20,	-	1.065	12—15	8.62	-	-	-
Pear (Bartlett),‡ . . .	Sept. 22,	-	1.060	12—15	8.93	-	-	-
Cranberries, ...	-	10.71	1.025	15	1.35	-	-	-§
Cranberries, ...	1878.	10.11	1.025	15	1.70	-	-	-‖
Early York Peach (ripe), .	-	-	1.045	25	-	1.92	6.09	45
Early York Peach (nearly ripe),	-	10.96¶	1.039	25	-	1.36	4.12	42.3
Crawford Peach (nearly ripe),	-	-	1.050	18	-	2.19	7.02	85.6
Crawford Peach (mellow), .	-	11.36¶	1.055	18	-	1.70	8.94	76
Crawford Peach (not mellow),	-	11.88¶	1.045	22	-	1.67	5.92	64

* One part Na_2CO_3 in 100 parts of water.

† Picked October 9.

‡ Picked September 7.

§ Free acid, 2.25 per cent.

‖ Free acid, 2.43 per cent.

¶ In pulp, kept ten days before testing.

C. Analyses of Fruits — Continued.

[Wild and cultivated grapes.]

NAME.	Date.	Specific Gravity.	Temperature C. (Degrees).	Dry Matter.	Glucose in Juice.	Sugar in Dry Matter.	*Soda Sol. required to neutralize 100 parts Juice.
	1876.			Per ct.	Per ct.	Per ct.	C.C.
Concord, ...	July 17,	1.0175	31	8.30	.645	7.77	-
Concord, ...	July 20,	1.0150	31	8.10	.625	7.72	216
Concord, ...	Aug. 2,	1.0200	25	9.94	.938	9.44	249
Concord, ...	Aug. 16,	1.0250	28	10.88	2.000	18.38	229
Concord, ...	Aug. 30,	1.0500	25	15.58	8.620	55.33	120
Concord, ...	Sept. 13,	1.0670	23	17.48	13.890	79.46	55
Concord, ...	Sept. 4,	1.0700	18	19.82	16.130	81.38	49.2
Wild Purple Grape, . . .	July 19,	1.020	31	9.00	.714	7.93	204
Wild Purple Grape, . . .	Aug. 4,	1.020	28	12.25	1.100	8.98	246
Wild Purple Grape, . . .	Aug. 16,	1.025	28	12.48	2.000	16.03	233
Wild Purple Grape, . . .	Aug. 30,	1.050	26	16.58	6.500	39.81	147.6
White Wild Grape, . . .	Aug. 31,	1.050	26	16.48	9.260	56.18	98
Hartford Prolific, ...	Sept. 5,	1.060	22	17.39	13.89	79.87	88.8
Ives' seedling, ...	Sept. 6,	1.070	26	20.15	15.15	75.14	88.6
Iona, ...	Sept. 7,	1.080	21	24.56	15.15	61.68	144
Iona (mildewed), ...	Sept. 7,	1.045	26	15.41	6.25	40.56	204.4
Agawam, ...	Sept. 11,	1.075	20	20.79	17.24	82.92	94.8
Wilder, ...	Sept. 11,	1.064	20	16.53	13.67	82.69	56
Delaware, ...	Sept. 12,	1.080	24	23.47	17.86	76.09	74
Charter Oak, ...	Sept. 12,	1.080	24	15.98	8.77	54.94	168.3
Israella, ...	Sept. 16,	1.075	23	19.67	9.20	46.77	89.8
Bent's Seedling, ...	Sept. 20,	1.080	21	20.65	16.13	78.11	181.8
Adirondack, ...	Sept. 20,	1.065	21	15.11	13.17	87.16	68
Catawba, ...	Oct. 16,	1.080	13	23.45	17.39	74.16	82
	1877.						
Wilder, ...	Sept. 11,	1.065	23	16.41	15.15	92.32	60
Charter Oak, ...	Sept. 12,	1.055	23	16.22	9.80	60.42	96
Concord, ...	Sept. 13,	1.065	24	15.90	13.16	82.76	102
Concord, ...	Sept. 26,	1.075	24	19.34	15.43	79.78	70.8
Eumalan, ...	Sept. 24,	1.065	16	19.62	13.16	67.07	73
Wild White Grape, . . .	Sept. 5,	1.050	22	15.57	7.20	46.24	140.8
Wild White Grape (shrivelled), .	Sept. 20,	1.060	16	20.02	10.00	49.95	130
Wild Purple Grape (shrivelled), .	Sept. 20,	1.045	16	16.69	8.22	49.25	104

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* One part of pure Na_2 CO_3 in 100 parts water.

C. Analyses of Fruits — Continued.

[Effect of girdling on grapes.]

NAME AND CONDITION.	Date.	Specific Gravity.	Temperature C. (Degrees).	Dry Matter at 100° C.	Glucose in Juice.	Sugar in Dry Matter.	*Soda Sol. required to neutralize 100 parts Juice.
	1877.			Per ct.	Per ct.	Per ct.	C. C.
Hartford Prolific, not girdled,	Sept. 3,	1.045	19	12.85	8.77	68.25	111.4
Hartford Prolific, girdled,	Sept. 3,	1.065	19	17.18	12.50	72.76	100
Wilder, not girdled,	Sept. 3,	1.055	19	15.41	10.42	67.62	108.2
Wilder, girdled,	Sept. 3,	1.075	19	17.24	14.70	85.26	88.4
Delaware, not girdled,	Sept. 4,	1.065	19	15.75	11.76	74.66	101.2
Delaware, girdled,	Sept. 4,	1.075	19	19.14	15.15	79.16	94.4
Agawam, not girdled,	Sept. 4,	1.060	19	16.60	11.37	68.48	128.2
Agawam, girdled,	Sept. 4,	1.075	19	18.45	16.31	87.42	114.8
Iona, not girdled,	Sept. 6,	1.0625	22	16.60	13.51	68.31	131.4
Iona, girdled,	Sept. 6,	1.085	22	21.48	15.63	72.76	125.6
Concord, not girdled,	Sept. 6,	1.045	22	13.46	7.46	55.42	182.4
Concord, girdled,	Sept. 6,	1.070	22	17.53	13.88	79.18	102.8
Concord, not girdled,	Sept. 26,	1.065	22	17.63	13.70	78.27	66
Concord, girdled,	Sept. 26,	1.080	22	24.47	19.61	80.13	76.8
Concord, not girdled,	Oct. 5,	1.075	12	20.92	17.50	85.37	42
Concord, girdled,	Oct. 5,	1.085	12	-	17.86	-	54

	Date.	100 Parts of Grapes contained —			
		Ash.	Moisture.	Glucose.	Tartaric Acid.
	1889.				
Concord, not girdled,	Sept. 23,	-	84.60	6.24	.75
Concord, girdled,	Sept. 23,	.42	83.00	8.13	.85
Concord, not girdled,	Oct. 8,	.53	84.51	6.09	.48
Concord, girdled,	Oct. 8,	.37	82.60	8.50	.50
	1890.				
Concord, not girdled,	Sept. 25,	.47	86.49	7.36	1.15
Concord, girdled,	Sept. 25,	.48	84.93	9.29	1.17
Concord, not girdled,	Oct. 9,	.53	85.39	7.67	.71
Concord, not girdled,	Oct. 9,	.59	85.11	6.65	.61
Concord, girdled,	Oct. 9,	.54	85.15	9.12	.74

* One part of pure Na_2CO_3 in 100 parts water.

C. Analyses of Fruits — Continued.

[Effect of fertilization upon the organic constituents of wild grapes.]

NAME.	Date.	Dry Matter.	Specific Gravity.	Temperature C. (Degrees).	Per Cent. of Glucose.	Per Cent. of Acids.	Remarks.
	1877.						
Wild Purple Grape Berries, .	Sept. 20,	16.31	-	-	8.03	-	Unfertilized.
Wild Purple Grape Berries, .	"	19.55	-	-	13.51	-	Fertilized.
Wild Purple Grape Juice, .	"	-	1.045	16	8.22	9.840	Unfertilized.
Wild Purple Grape Juice, .	"	-	1.065	16	18.51	1.149	Fertilized.
Wild White Grape Berries, .	"	20.02	-	-	-	-	Unfertilized.
Wild White Grape Berries, .	"	21.65	-	-	-	-	Fertilized.
Wild White Grape Juice, .	"	-	1.060	16	10.00	1.846	Unfertilized.
Wild White Grape Juice, .	"	-	-	-	14.29	.923	Fertilized.

[Effect of fertilization upon the ash constituents of grapes.]

NAME.	Date.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	Remarks.
	1876.								
Wild Purple Grapes,	Sept. 18,	50.93	.15	22.23	5.59	.79	17.40	2.93	Unfertilized.
Wild Purple Grapes,	Sept. 20,	62.65	.85	14.24	3.92	.53	13.18	4.63	Fertilized.
Concord Grapes, .	July 7,	41.73	5.04	25.03	7.80	.55	18.48	1.37	Unfertilized.
Concord Grapes, .	July 17,	47.34	1.13	24.21	-	.75	21.38	.43	Unfertilized.
Concord Grapes, .	Aug. 18,	51.14	3.19	16.20	6.38	.65	20.77	1.67	Unfertilized.
Concord Grapes, .	Sept. 13,	57.15	4.17	11.30	3.10	.40	12.47	11.82	Unfertilized.
	1878.								
Concord Grapes, .	Oct. 3,	64.65	1.42	9.13	3.63	.50	14.87	5.80	Fertilized.

C. Analyses of Fruits — Concluded.

[Ash analyses of fruits and garden crops.]

NAME.	Ash.	100 PARTS OF ASH CONTAINED—						
		Potash.	Soda.	Lime.	Magnesia.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.
Concord Grape (fruit), . .	-	51.14	3.19	16.20	6.38	.65	20.77	1.67
Unfermented juice, . .	-	50.85	.48	3.69	4.25	.10	6.43	.90
Fermented juice, . .	-	40.69	-	6.85	6.24	-	9.04	-
Skins and pulp, . . .	-	7.70	.42	57.36	8.80	.08	24.40	1.32
Seeds, ...	3.08	6.71	-	-	3.03	-	17.20	.29
Stems of grapes, . . .	4.69	20.91	-	20.20	8.45	-	17.75	2.09
Young branches,* . .	-	24.71	.94	40.53	10.66	1.08	17.16	4.92
Wood of vine,† . . .	2.97	22.57	-	9.72	4.28	-	14.07	23.84
Concord Grapes, 1891,‡ . .	.55	49.76	-	3.50	2.53	1.19	13.56	2.01
Clinton Grape (fruit), . .	-	58.45	3.51	13.34	7.37	.90	18.19	-
Baldwin Apple, ...	-	63.54	1.71	7.28	5.52	1.08	20.87	3.68
Strawberry (fruit),§ . . .	.52	49.24	3.23	13.47	8.12	1.74	18.50	5.66
Strawberry (fruit),‖ . . .	-	58.47	-	14.64	6.12	3.37	17.40	-
Strawberry vines, . . .	3.34	10.62	13.35	36.63	3.83	6.91	14.48	14.17
Cranberry (fruit), . . .	.18	47.96	6.58	18.58	6.78	-	14.27	-
Cranberry vines, . . .	2.45	12.98	3.27	16.49	10.33	3.35	10.94	34.04
Currants, red, ...	.47	47.68	4.02	18.96	6.23	1.20	21.91	-
Currants, white, . . .	.59	52.79	3.00	17.08	5.68	2.67	18.78	-
Crawford Peach, sound, . .	-	74.46	-	2.64	6.29	.58	16.02	-
Crawford Peach, diseased,¶ .	-	71.30	-	4.68	5.49	.46	18.07	-
Branch, sound, . . .	-	26.01	-	54.52	7.58	.52	11.37	-
Branch, diseased,¶ . .	-	15.67	-	64.23	10.28	1.45	8.37	-
Carnation Pinks (whole plant),**	8.80	38.07	12.84	18.64	3.98	.34	5.23	.24
Asparagus stems, . . .	-	42.94	3.58	27.18	12.77	1.22	12.31	.08
Asparagus roots, . . .	-	56.43	5.42	15.48	7.57	-	15.09	3.67
Onions, ...	-	38.51	1.90	8.20	3.65	.58	15.80	3.33

* With tendrils and blossoms.

† One year old.

‡ Nitrogen in dry matter, .96 per cent.

§ Wilder.

‖ Downing.

¶ Yellows.

** Nitrogen in dry matter, 1.15 per cent.

D. *Analyses of Sugar-producing Plants.*

[Composition of sugar beets raised upon the college grounds during the season of 1870 and 1871.]

NAME.	Date.	Brix Saccharometer (Degrees).	Per Cent. of Sugar.	Non-saccharine Substances.
Electoral, ...	Sept. 10,	14	12.30	1.75
Imperial, ...	" 12,	15	12.59	2.41
Vilmorin, ...	" 13,	14.5	12.95	1.55
Imperial, ...	" 18,	14	10.79	3.21
Imperial, ...	Oct. 11,	15	12.05	2.95
Electoral, ...	" 16,	15	12.22	2.78
Vilmorin, ...	" 18,	16	13.13	2.87
Imperial, ...	Nov. 14,	15	11.60	3.34
Vilmorin, ...	" 21,	15.5	13.12	2.38
Vienna Globe,*	Sept. 19,	11	8.00	3.00
Common Mangold,* . . .	" 19,	9	5.00	3.97

* Fodder beets.

[Percentage of sugar in different varieties of sugar beets grown on college farm during the season of 1882.]

NAME.	Source of Seed.	Weight in Pounds.	Per Cent. of Sugar in Juice.
I. Vilmorin, ...	Saxony, .	¾ to ⅞	15.50
II. Vilmorin, ...	Saxony, .	¾ to 1	15.61
I. White Imperial, ...	Saxony, .	¾ to 1¾	14.20
II. White Imperial, ...	Saxony, .	1¾ to 2	10.27
New Imperial, ...	Saxony, .	1¼ to 1¾	13.80
I. White Magdeburg, ...	Saxony, .	1½ to 2	13.10
II. White Magdeburg, ...	Silesia, .	1½ to 1¾	10.06
Quedlinburg, ...	Saxony, .	1½ to 1¾	13.44
White Silesian, ...	Silesia, .	1¼ to 1½	9.72

D. Analyses of Sugar-producing Plants — Continued.

[Effect of soil and fertilization on Electoral sugar beets.*]

SOIL.	MANURE.	Specific Gravity Brix (Degrees).	Per Cent. of Sugar in Juice.	Non-saccharine Substances.	Cane Sugar in Soluble Matter.
Sandy loam, .	Fresh yard-manure, .	16.5	12.50	4.00	75.08
Clayish loam, .	Fresh yard-manure, .	15.5	11.05	4.45	71.30
Warm alluvial, .	Yard-manure and chemicals, . . .	12.75	9.17	3.58	71.92
Warm alluvial, .	Fresh hog-manure, .	13.5	9.53	3.97	70.06
Light, sandy soil,	No manure, . . .	18.5	13.73	4.77	74.21
Alluvial soil, .	Brighton fish, . .	14.5	11.15	3.35	76.90
Heavy soil, .	Yard-manure, . .	12.25	8.15	4.10	66.53
–	–	13.5	9.90	3.60	73.33

* Not raised on college farm (Connecticut valley).

[Effect of fertilization on sugar beets.*]

FERTILIZERS.	PERCENTAGES OF SUGAR IN JUICE.		
	Freeport.	Electoral.	Vilmorin.
Fresh horse-manure, ...	11.96	9.42	7.80
Blood guano without potash, . .	10.99	10.10	10.20
Blood guano with potash, . . .	12.55	13.24	10.50
Kainite and superphosphate, . .	13.15	12.16	10.50
Sulphate of potash, ...	14.52	14.32	12.78
Second year after stable-manure, .	13.49	12.78	12.19

* All were grown on the same soil, — sandy loam (college).

D. Analyses of Sugar-producing Plants — Continued.

[Effect of different modes of cultivation on Electoral sugar beets.]

LOCALITY OF BEET-FIELD.	Date.	Brix Saccharometer (Degrees).	Per Cent. of Cane Sugar.	Non-saccharine Substances.
1. Sing Sing, N. Y., . . .	1872–73	11	7.80	3.20
2. Washington, N. Y., . . .	"	14	10.97	3.03
3. South Hartford, N. Y., . .	"	15	11.70	3.30
4. Greenwich, N. Y., . . .	"	12	9.50	2.50
5. Frankfort, N. Y., . . .	"	13.5	11.00	2.50
6. Albion, N. Y.,* . . .	"	18	15.10	2.90
Albion, N. Y.,† . . .	"	14	9.70	4.30

* From beets weighing from 1½ to 2 pounds. † From beets weighing from 10 to 14 pounds.

1. Soil, loam resting on clayish hard-pan, had been for several years in grass. Tomatoes had been the preceding crop. Five hundred pounds of a phosphatic blood guano were applied before planting.

2. Soil, a clayish loam, had been ploughed seven inches deep. A liberal amount of rotten sheep-manure was placed in trenches and covered by running two furrows together, thus forming a ridge on which the seed were planted.

3. Soil, a gravelly loam, which had been richly manured with stable compost and twice ploughed before planting.

4. Soil, a sandy loam, underlaid by fine sand. The seed were planted on ridges, which covered trenches containing a little rotten stable-manure.

5. No details of modes of cultivation received.

6. Soil, a dark, reddish-brown, rich, deep, sandy loam. Clover had been raised for two years previous to a crop of carrots, which preceded the sugar beets. The beets were the second crop after the application of twenty loads of stable-manure per acre.

Composition of Canada-grown Sugar Beets.

[1872 and 1873.]

WHERE GROWN.	Weight of Roots.	Specific Gravity of Juice (Brix).	Temperature of Juice.	Per Cent. of Cane Sugar in Juice.
Echaullon de Montreal, . .	2 to 2½ lbs.	15.4°	64° F.	11.38
Riviere du Loup, . . .	2 to 3¼ lbs.	14.5°	63° F.	10.20
Chambly, ...	2 to 2½ lbs.	13.2°	63° F.	9.02
Maskinonge, ...	2 to 3 lbs.	13.4°	63° F.	8.83

D. Analyses of Sugar-producing Plants — Continued.

[Early Amber Cane.]

DATE.	CONDITION OF CANE.	Brix Saccharometer (Degrees).	Temperature C. (Degrees).	Glucose.	Cane Sugar.	Soda solution required to neutralize 100 parts of Juice.	Solids.
1879.				Per ct.	Per ct.	C. C.	Per ct.
Aug. 15,	No flower stalks in sight,*	4.2	27	2.48	None.	6.8	7.93
Aug. 16,	No flower stalks in sight,*	5.8	24	4.06	None.	9.0	11.10
Aug. 20,	Flower stalks developed,*	7.9	24	3.47	2.15	7.0	13.00
Aug. 24,	Flowers open,*	8.7	23	3.70	3.00	4.0	14.07
Aug. 27,	Plants in full bloom,*	10.0	25	3.65	4.13	10.0	15.48
Aug. 30,	Seed forming,*	9.5	30	4.00	3.81	9.5	16.14
Sept. 2,	Seed in milk,*	10.7	27	3.85	4.41	9.5	15.85
Sept. 9,	Seeds still soft,*	12.1	22	3.21	6.86	9.5	26.13
Sept. 9,	Stripped on Sept. 2,*	12.8	22	3.77	6.81	9.5	26.75
Sept. 18,	Left on field without stripping,*	13.2	22	3.57	7.65	–	–
Sept. 18,	Tops removed,*	13.8	22	3.16	8.49	–	–
Sept. 18,	Tops and leaves removed on Sept. 9,*	11.5	22	3.16	5.85	–	–
Sept. 18,	Tops removed; left on field 9 days,*	12.8	22	10.00	.60	–	–
Sept. 21,	Juice from the above,*	13.0	21	–	–	–	–
Sept. 23,	Juice from the above,*	15.0	18	–	–	–	–
Sept. 25,	Left on field 3 weeks,†	19.8	21	11.91	6.27	–	–
Sept. 28,	Left on field 3 weeks,†	17.8	12	16.60	–	–	–
Oct. 4,	Left on field 3 weeks,†	16.1	17	8.62	6.16	12.0	–
Oct. 7,	Freshly cut. Ground with leaves,†	16.7	20	4.16	9.94	6.8	–
Oct. 8,	Freshly cut. Stripped two weeks,†	12.8	17	5.16	5.27	7.0	–
Oct. 9,	Freshly cut. Stripped two weeks,†	18.4	17	7.57	–	10.6	–
Oct. 14,	Several weeks old,†	18.2	15	10.42	–	10.4	–
Oct. 18,	Several weeks old,†	15.1	23	7.57	–	–	–
Oct. 19,	Several weeks old,†	15.5	15	9.22	–	13.6	–
Oct. 22,	Several weeks old,†	16.2	16	8.30	–	–	–
Oct. 23,	Several weeks old,†	18.3	17	11.30	5.5	14.0	–
Oct. 24,	Several weeks old,†	16.6	15	8.63	–	9.0	–

		100 PARTS OF CANE CONTAINED —				
		Moisture.	Glucose.	Cane Sugar.	Total Sugar.	
1889.						Grown on station grounds.
October,	Early Tennessee sorghum, mature,	77.43	1.79	3.21	5.00	
October,	Price's new hybrid, ripe,	77.80	2.92	3.78	6.70	
October,	Kansas orange, green,	80.67	2.38	3.63	6.01	
October,	New orange, green,	78.30	2.96	3.85	6.81	
October,	Honduras, green,	77.55	3.08	4.01	7.09	

* Raised on the college farm. † Raised by farmers in the vicinity of the college.

D. Analyses of Sugar-producing Plants — Concluded.

[Composition of the juice of corn stalks and melons.]

VARIETY.	Specific Gravity.	Temperature C. (Degrees).	Glucose.	Cane Sugar in Juice.	Solids.
			Per ct.	Per ct.	Per ct.
Northern corn,*	1.023	27	4.35	0.28	15.18
Black Mexican sweet corn,†	1.048	27	2.06	7.02	17.44
Evergreen sweet corn,†	1.052	-	4.85	5.70	20.38
Common sweet corn,‡	1.035	-	6.60	None.	-
Common yellow musk-melon,§	1.040	26	1.67	2.65	-
White-flesh water-melon,	1.025	18	2.91	2.16	-
Red-flesh water-melon,	1.025	22	3.57	2.18	-
Red-flesh water-melon,	1.025	19	3.84	1.77	-
Nutmeg musk-melon,‖	1.030	19	3.33	2.11	-
Nutmeg musk-melon,¶	1.050	20	2.27	5.38	-
Nutmeg musk-melon,**	1.030	19	2.50	1.43	-

* Tassels appearing.
† Ears ready for the table.
‡ Kernels somewhat hard.
§ Fully ripe.
‖ Not ripe.
¶ Ripe.
** Over-ripe.

E. Analyses of Dairy Products.

	Analyses.	SOLIDS.			FAT.			CURD.			SALT.			Ash.
		Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	
Whole milk,	1,889	18.27	10.20	13.47	7.54	1.72	4.14	-	-	3.20	-	-	-	.70
Skim-milk,	348	10.48	7.68	9.48	1.02	.05	.32	-	-	3.53	-	-	-	.80
Buttermilk,	31	9.86	6.83	8.33	.38	.11	.27	-	-	2.79	-	-	-	.80
Cream (from Cooley Creamer),	197	32.78	18.12	26.10	25.00	10.53	17.66	-	-	-	-	-	-	.62
Butter,	25	92.89	87.05	89.11	89.05	81.43	83.95	.89	.51	.66	6.45	3.46	4.74	-
Whole-milk cheese (Jersey),*	1	-	-	62.64	-	-	37.32	-	-	22.13	-	-	-	3.39
Whole-milk cheese,*	1	-	-	64.17	-	-	34.34	-	-	26.69	-	-	-	3.14
Cheese from milk skimmed after twelve hours' standing,*	1	-	-	62.70	-	-	27.81	-	-	30.37	-	-	-	4.52
Cheese from milk skimmed after twenty-four hours' standing,*	1	-	-	57.76	-	-	23.42	-	-	31.99	-	-	-	2.35
Cheese from milk skimmed after thirty-six hours' standing,*	1	-	-	56.05	-	-	17.67	-	-	33.24	-	-	-	5.14
Cheese from milk skimmed after forty-eight hours' standing,*	1	-	-	54.59	-	-	15.77	-	-	34.94	-	-	-	3.38
Cheese from skim-milk, with addition of buttermilk,*	1	-	-	51.62	-	-	18.35	-	-	28.63	-	-	-	4.04
Genuine oleomargarine cheese,*	1	-	-	62.10	-	-	31.66	-	-	25.94	-	-	-	4.50

* From analyses made in 1875.

E. *Salt for Meat Packing and Dairy Purposes.*

KIND AND SOURCE.	Moisture, 100° C.	Sodium Chloride.	Calcium Sulphate.	Calcium Chloride.	Magnesium Chloride.	Sodium Sulphate.	Magnesium Sulphate.	Insoluble Matter.	Remarks.
Rock salt of Pettite Anse, La.,	.330	98.882	.782	.004	.003	-	-	-	Sent on for examination.
Rock salt of Neyba, San Domingo, W. I.,	.300	98.330	1.480	-	.090	.070	.070	-	
Solar salt, Onondaga, N. Y.,	2.500	96.004	1.315	.092	.089	-	-	-	
Solar salt, Hocking Valley, O.,	2.130	97.512	None.	.234	.089	-	-	-	
Solar salt, Saginaw Valley, Mich.,	3.344	95.813	.316	.356	.140	-	-	-	
Solar salt from Kansas,	4.950	93.060	1.220	-	.240	.350	.180	-	
Solar salt, Lincoln County, Neb.,	1.200	98.130	.250	-	.080	.390	None.	-	
Common fine and boiled salt, Onondaga, N. Y.,	3.000	95.353	1.355	.155	.136	-	-	-	
Common fine and boiled salt, Portsmouth, Mich.,	6.752	90.682	.805	.974	.781	-	-	-	
Common fine and boiled salt, Mason City, O.,	3.470	95.789	-	.614	.041	-	-	-	
Dairy and table salt, Ashton's (English),	0.760	97.652	1.430	-	.060	-	.048	.050	
Onondaga dairy salt,	0.700	97.832	1.263	-	.037	.026	.023	.120	
Fine salt, Bulletin 26, I.,	3.280	95.091	1.487	.032	.075	-	-	.035	
Fine salt, Bulletin 26, II.,	4.591	94.012	1.177	.143	.049	-	-	.028	
Fine salt, Bulletin 26, III.,	4.616	94.236	.999	.071	.026	-	-	.052	Salicylic acid: trace.
Dairy salt, sent on from Amherst, Mass.,	0.145	98.520	1.009	.189	.065	-	-	.072	
Ashton salt (sent on),	.760	97.650	1.430	-	.060	-	.050	.050	
Onondaga factory-filled (sent on),	.600	98.280	.910	-	-	.030	.060	.120	
Dairy salt, sent on from Amherst,	.505	98.202	.877	.168	.046	-	-	.202	
Rock salt from Retsof salt mines,	2.600	95.940	.420	.330	.010	-	-	.700	
Royal salt,	.880	97.877	1.108	.016	.010	-	-	.102	
Excelsior salt,	.320	98.009	1.644	.013	.014	-	-	.020	
Genesee salt,	.295	98.513	1.160	.010	.012	-	-	.010	
Genesee salt,	.235	98.563	1.137	.045	.020	-	-	-	
Bradley salt,	.200	98.575	1.185	.029	.007	-	-	-	
Higgins' Eureka salt,	.855	98.891	.906	.293	.055	-	-	-	
Worcester refined salt,	.565	97.935	1.376	.097	.027	-	-	-	

F. Analyses of Insecticides.

	Moisture.	Arsenious Oxide.	Copper Oxide.	Acetic Acid.	Nicotine.	Mercury.	Sulphur.	Sulphuric Acid.	Chlorine.	Calcium Oxide.	Potassium Oxide.	Ferric and Aluminic Oxides.	Insoluble Matter.
Paris green, ...	1.30	62.55	32.84	3.10	-	-	-	-	-	-	-	-	0.21
Paris green, ...	1.41	61.40	33.20	3.90	-	-	-	-	-	-	-	-	0.09
Paris green, ...	1.40	61.15	33.10	3.71	-	-	-	-	-	-	-	-	0.64
Paris green, ...	1.15	53.91	31.27	8.10	-	-	-	-	-	-	-	-	0.04
Paris green, ...	1.34	61.25	33.35	3.93	-	-	-	-	-	-	-	-	0.13
Paris green, ...	1.31	61.21	33.45	3.94	-	-	-	-	-	-	-	-	0.09
Paris green, ...	1.15	59.92	30.40	-	-	-	-	-	-	-	-	-	0.10
Paris green, ...	1.27	54.80	30.85	6.50	-	-	-	-	-	-	-	-	0.12
"Sulphatine,"	1.40	-	2.61	-	-	-	48.28	4.73	-	18.60	-	-	1.63
"Death to Rose Bugs,"	2.95	-	1.05	-	-	-	34.53	4.35	-	17.76	-	-	0.49
"Professor De Graff's Carpet Bug Destroyer,"	95.81	-	-	-	-	0.78	-	0.48	0.27	-	0.26	0.90	-
"Oriental Fertilizer and Bug Destroyer,"	87.14	2.38	-	-	-	-	-	.64	3.00	-	3.50	-	-
"Non-poisonous Potato Bug Destroyer,"	-	-	-	-	-	-	-	-	-	68.20	-	1.38	1.50
Tobacco liquor, ...	37.71	-	-	-	2.12	-	-	-	-	3.07	6.55	0.23	-
Tobacco liquor, ...	40.89	-	-	-	0.53	-	-	-	-	1.47	16.34	0.01	-
Tobacco liquor, ...	-	-	-	-	4.55	-	-	-	-	-	-	-	-
Tobacco liquor, ...	-	-	-	-	4.82	-	-	-	-	-	-	-	-
"Nicotinia,"	10.00	-	-	-	-	-	-	-	-	4.45	9.15	-	2.12
Hellebore, ...	-	-	-	-	-	-	-	-	-	-	-	-	2.34
Hellebore, ...	-	-	-	-	-	-	-	-	-	-	-	-	38.12
"Peroxide of Silicate,"	1.65	0.57	0.33	-	-	-	-	49.66	-	41.18	-	-	2.31

VI. TABLES OF THE DIGESTIBILITY OF AMERICAN FEED-STUFFS.

EXPERIMENTS MADE IN THE UNITED STATES.

COMPILED BY J. B. LINDSEY.

I. EXPERIMENTS WITH RUMINANTS.

II. EXPERIMENTS WITH SWINE.

DEC. 31, 1894.

TABLES OF THE DIGESTIBILITY OF AMERICAN FEED STUFFS.

I. EXPERIMENTS WITH RUMINANTS.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Hay and Dry Coarse Fodders.								
Timothy hay (in bloom), ...	3	5	55.6—65.7 60	56.4—66.8 60	55.8—62.1 58	51.5—61.8 57	50.3—60.4 56	57.5—71.8 63
Timothy hay (past bloom), ...	4	7	47.0—61.1 53	48.4—62.3 54	37.2—56.8 46	34.6—61.1 54	38.8—50.4 45	55.6—66.9 60
Timothy hay (average all trials), ...	10	22	58	58	53	61	48	63
Hay of mixed grasses (medium in protein*), ...	1	2	-	-	49	50	40	58
Hay of mixed grasses (rich in protein), ...	4	14	54—62 58	- -	56—66 60	44—57 49	56—64 59	56—63 59
Hay of vetch and oats, ...	1	2	58—58 58	- -	65—67 66	17—20 19	60—61 60	54—54 54
Clover and timothy hay (poorly cured), ...	1	2	54.3—55.8 55	- -	52—54.4 53	- 58	37.5—37.9 38	- 60
Hungarian hay, ...	1	2	64.3—65.8 65	65.9—66.8 66	66.8—68.5 68	- 64	- 60	66.9—67.4 67
Hay of blue-joint grass (past bloom), ...	1	1	40	42	37	37	57	43
Hay of blue-joint grass (bloom), ...	1	2	66.7—70.5 69	68.1—71.5 70	71.5—73.4 72	51.4—53.3 52	68.2—72.8 70	66.4—70.9 69
Hay of orchard grass (ten days after bloom), ...	1	1	54	56	58	54	59	54
Hay of orchard grass (stage not given), ...	1	2	57.5—60 50	- -	60—66.7 64	55.4—57.4 56	60—60.8 60	55.8—57.8 56

Average of both samples,	2	3	56	56	61	55	60	55
Hay of red top,	2	3	57.6—62.3 60	59.3—63.6 61	60.8—61.8 61	44.2—58.8 51	60.4—62.4 61	59.1—65.2 62
Dried pasture grass,	1	1	71	-	77	60	72	73
Oat straw,	1	2	49—51.7 50	50.8—53.2 52	57.2—58 58	35.5—41 38	- -	51.8—54.6 53
Barley hay,	1	4	59	62	62	41	65	63
Hay of Legumes.								
Soja-bean hay,	1	2	61.9—62.7 62	- -	59.5—62.1 61	18.7—39.7 29	70.1—72.1 71	66.1—71.5 69
Peanut-vine hay,	1	2	59.5—60.2 60	- -	51.2—52.6 52	62.1—69.8 66	63—63.6 63	69.3—69.7 70
Cow-pea-vine hay (fair quality),	1	2	- 59	- -	41.2—44.6 43	46.4—53.7 50	63.9—65.1 65	- 71
Clover hay (late bloom, fair quality),	1	2	54.4—55.5 55	55.9—56.4 56	43.8—49 46	51.8—54.8 53	49.3—59.1 55	63.3—64.8 64
Clover hay (good quality),	1	2	50.8—53.5 52	51.6—54.3 53	46.6—49 48	40—48 43	47—52.2 49	56.8—58.9 58
White clover hay (bloom),	1	1	66	67	61	51	73	76
Scarlet clover hay (*T. incarnatum*),	1	2	56.8—65.4 62	- -	42.6—58.1 50	35.1—54 46	66.5—70 69	63.4—73.6 69
Alsike clover (*T. hybridum*),	2	3	61.1—64.3 62	62—65.2 63	51—58.7 53	35.1—69.3 50	64—69.2 66	66.5—74.1 71
Alfalfa (lucerne) (late bloom),	1	2	-	-	49	54	77	64
Alfalfa (lucerne) (stage not given),	1	1	-	-	43	48	69	72

* Below ten per cent.

Table of the Digestibility of American Feed Stuffs — Continued.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Corn Fodders (partially Air Dry).								
Corn stover (whole plant),	1	4	61.1—62 62	- -	64.8—68.3 67	48.1—55.8 52	49.6—54.8 52	62.5—64.5 64
Corn stover (tops and blades),	1	2	59—60.5 60	- -	71.1—71.7 71	70.6—71.9 71	54.2—56.6 55	61.9—62.6 62
Corn stover (leaves of),	1	2	54.8—56.2 56	- -	54.3—67 61	60.6—65.4 63	43.1—68.8 56	57.1—60.6 59
Corn stalk (below ear),*	1	2	64—69 67	- -	71—75 74	79—80 80	15—27 21	65—73 69
Topped stover (part above ear),*	1	2	52—58 55	- -	69—72 71	62—65 64	17—27 22	50—57 54
Corn husks,*	1	2	71—73 72	- -	78—81 80	23—42 33	24—35 30	75 -
Corn leaves (below ear),*	1	2	62—67 65	- -	75—80 78	52—59 56	28—41 55	66—70 68
Flint corn fodder (ears just forming),	1	3	69—72 70	71—73 71	72—73 72	63—71 67	69—73 70	71—73 71
Flint (mature) field corn fodder,	4	9	68—73 71	71—75 73	69—80 76	59—77 70	59—79 65	69—78 73
Dent (mature) field corn fodder,	5	10	63—70 68	- -	43—61 54	72—82 78	43—61 53	68—81 76
Average both kinds,	-	-	70	-	65	74	59	74
Dent (in milk) field corn fodder,	5	11	58.8—66 63	- -	50—71 64	67—79 75	44—51 50	61—69 66

Dent (immature, Burrill and Whitman, coarse),	1	4	51—64 57	- -	45—74 59	66—84 76	20—36 27	57—66 61
Dent (immature, no ears formed),	4	8	61—70 65	63—71 67	63—77 71	59—72 66	57—67 62	57—70 64
Sweet corn fodder (mature),	3	6	60—71 67	62—74 70	70—77 74	63—71 74	54—78 64	57—73 68
Miscellaneous Dry Substances.								
Hay of wild oat grass (*Danthonica spicata*),	2	3	59.6—68.3 64	61.2—69.1 65	65.1—70.6 68	38.2—62.8 50	48.6—68 58	62.1—68.8 65
Hay of witch grass (*Triticum repens*),	2	4	59.9—62.7 61	61—64.3 62	56.4—67.6 62	53.6—60 57	49.5—64.2 58	62.1—69.9 66
Hay of buttercups (*Ranunculus acris*),	1	2	56	57	41	70	56	67
Hay of white weed (*Leucanthemum vulgare*),	1	2	58	58	46	62	58	67
Cat's-tail millet (*Pennesetum spicatum*),	1	2	61.1—63.6 62	- -	64.7—68.4 67	44.7—47.6 46	60.6—64.6 63	58.8—60 59
Johnson-grass hay,	1	1	55	-	58	39	45	54
Sorghum fodder (leaves),	1	2	59.9—66.3 63	- -	64.9—75.9 70	46.3—47.1 47	59.5—62.2 61	62.5—66.6 65
Sorghum bagasse,	1	1	61	-	64	46	14	65
Cotton-seed hulls,	4	13	35—47.5 41	- -	.54—57.6 47	58.2—89.3 79	.00—24.6 6	12.9—45.7 34
Green Fodders.								
Dent corn fodder (immature),	4	11	64—74 68	- -	60—76 67	37—83 68	56—80 66	64—79 71
Dent corn fodder (in milk),	3	9	70	-	64	78	61	76
Dent corn fodder (glazing),	5	9	67	-	51	78	54	75

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* Made at Maryland Experiment Station. It will be noticed that the coefficients of protein digestibility are very much below those obtained in other experiments. The animals were fed but six pounds each per day, with no other food, and it is probable that the metabolic nitrogen products excreted were in a measure at least the cause of the low results obtained.

Table of the Digestibility of American Feed Stuffs — Continued.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent).	Crude Protein (Per Cent).	Extract Matter (Per Cent).
Green Fodders — Concluded.								
Dent corn fodder (mature),	2	4	65	-	55	73	51	72
Average (glazing and mature),	7	13	66	-	52	76	53	74
Dent corn fodder (ears glazing, Burrill and Whitman, coarse),	1	2	51—54 52	- -	46—47 46	74—82 78	20—28 24	57—61 59
Sweet corn fodder (milk),	1	2	77—78 77	- -	74—76 75	73—74 74	77—78 77	80—81 81
Early amber sorghum (just after blossom),	1	2	60.9—61.7 61	- -	41.7—45.3 42	67 -	37.7—42.5 40	70.4—70.8 71
Sorghum in blossom (variety not stated),	1	2	73.1—73.3 73	- -	74—75 75	81.3—81.6 81	51.1—55.7 53	78.2—78 78
Average both samples,	2	4	67	-	59	74	46	74
Green grass (young),	1	1	69	-	74	55	65	72
Same (dry),	1	1	71	-	77	60	71	73
Pasture grass,	1	2	71.9—75.6 74	- -	74.6—76.5 76	74—74.9 74	74—76.5 75	73.8—77.1 75
Average of three samples,	-	-	71	-	76	63	70	73
Soiling rye (formation of head),	1	2	73.2—74 74	- -	78.9—80.4 80	73.6—74.8 74	78.6—79.7 79	69.7—71.4 71
Soiling clover (late blossom),	1	2	64.9—67.3 66	- -	52.3—52.9 53	63—66.1 65	65.8—68.3 67	76.1—79.3 78
Hungarian grass (probably in bloom),	1	4	61—67 63	63.4—68.8 66	65.4—71.7 68	47.8—56 52	59.4—66.4 62	63.5—68.4 66

Corn Silage.								
Dent silage (immature), ...	4	10	60—68 64	- -	71—78 71	61—85 72	42—65 52	60—70 66
Dent silage (milk), ...	4	12	60—74 65	- -	45—80 64	78—90 87	45—63 52	63—78 69
Dent silage (average of both), ...	8	23	65	-	68	80	52	67
Dent silage (stage uncertain, North Carolina), ...	1	4	53—67 60	- -	43—64 56	55—79 70	19—34 24	61—76 68
Flint silage (ears glazing), ...	3	8	68—78 75	66—80 77	75—78 77	- 80	48—73 65	71—88 79
Fine crushed silage (steers), ...	1	2	60.4—68 64	- -	72—78 75	75—77 76	32—44 38	60—70 65
Fine crushed silage (sheep), ...	1	2	51.5—56 54	- -	59.5—67.7 64	67.5—69 68	21—22 21.5	52.6—57.3 55
Corn silage (raw, ears mature), ...	1	1	-	-	59	86	45	71
Same (cooked), ...	1	1	-	-	70	87	39	75
Sweet corn ensilage (occasional ears mature), ...	1	2	66.6—69.6 68	68.5—71.7 70	68.4—73.7 71	82.3—84.6 83	52.7—55.2 54	70.7—73 72
Soja-bean ensilage, ...	1	2	52.2—65.8 59	- -	47.1—62.5 55	66.4—77.3 72	71.8—80.2 76	45.9—58.2 52
Roots, Tubers, etc.								
Potatoes, ...	1	3	73.3—80.1 77	74.6—81.2 78	- -	13 -	43.4—45.4 44	87.3—93.4 91
Sugar beets, ...	1	2	94.2—94.8 95	97.6—99.9 99	88.5—113 100	46.4—53.5 50	90—92.6 91	99.8—100 100
Mangolds, ...	1	2	77.1—80 79	82.7—87 85	26.8—58.8 43	- -	69.7—79.8 75	90.8—91.9 91

Table of the Digestibility of American Feed Stuffs — Continued.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Roots, Tubers, etc. — Concluded.								
English flat turnips,	1	2	90.7—94.9 93	93.2—99 96	89.2 - 117 100	82.5 - 92.5 88	84.5—95 90	96—97 97
Ruta-bagas,	1	2	84.4—90 87	89.2—93 91	61—87.5 74	76.8—91.6 84.2	74.7—85.9 80.3	91.4—95.1 95
Grains.								
Corn meal (maize),	2	5	83—98 88	- -	- -	80—98 92	40—77 60	85—100 93
Corn and cob meal,	1	3	74—83 79	- -	2—86 45	82—85 84	43—65 52	86—91 88
Pea meal,	1	2	85—88 87	86—89 88	25—26 26	52—57 55	80—86 83	93—94 94
Raw cotton seed,	1	2	63—69 66	- -	65—86 76	- 87	66—70 68	49—50 50
Roasted cotton seed,	1	2	53—58 56	- -	62—69 66	68—75 72	44—50 47	50—53 51
Soja-bean meal,	1	2	78—86 82	- -	48—94 71	81—90 86	90—92 91	76—77 76
By-products.								
Cotton-seed meal,	2	6	67—82 76	- -	- 32	87—100 93	83—96 88	44—78 64
Gluten meal,	1	2	85—90 87	86—92 89	- 33	86—90 88	83—90 87	88—94 91

Chicago gluten meal,	1	2	92–94 93	- -	4–39 22	96–98 97	89–92 90	96–97 97
King gluten meal,	1	2	84–87 85	- -	- -	92–98 95	- 92	82–86 84
Average gluten meals,	3	6	88	-	-	93	90	91
Buffalo gluten feed (one lot),	1	2	76–80 78	- -	40–46 43	81–82 81	84–86 85	78–84 81
Buffalo gluten feed (another lot),	1	2	89–91 90	- -	91–105 100	93–96 94	89–89 89	89–90 89
Peoria gluten feed,	1	2	84–87 86	- -	59–97 78	76–82 79	81–85 83	90–90 90
Chicago maize feed,	1	2	86–88 87	- -	78–86 82	91–92 92	85–86 85	86–90 88
Winter-wheat bran,	1	3	61–66 64	- -	5–56 28	53–80 65	78–79 78	70–72 71
Spring-wheat bran,	1	2	62–63 63	- -	22–25 24	76–76 76	78–82 80	70–71 70
Average all wheat brans,	4	9	61	63	22	71	78	69
Wheat middlings,*	1	2	72.6–72.2 76	75.1–79.3 77	- -	84.1–86.1 85	78.4–79.4 79	80.7–84.5 83
Wheat middlings,†	1	2	79.48–85.63 83	- -	32.57–40.06 36	81.71–87.98 85	81.83–87.75 85	84.43–91.08 88
New-process linseed meal,	1	3	77–83 80	- -	49–90 74	90–102 94	83–88 85	85–87 86
Old-process linseed meal,	1	3	75–82 79	- -	38–71 57	85–92 89	86–93 89	76–79 78
Atlas meal,	1	2	80–80 80	- -	95–116 106	90–92 91	73–73 73	84–85 84

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* Jordan.

† Very fine and quite light in color.

Table of the Digestibility of American Feed Stuffs— Concluded.

KIND OF FODDER.	Number of Different Samples	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
By-products — Concluded.								
Rye meal,	1	2	85—90 87	- -	- -	63—65 64	83—85 84	89—94 92
Peanut feed,	1	2	32—32 32	- -	10—13 12	89—90 90	70—71 71	41—58 49
Malt sprouts,	1	1	67	68	34	100	80	69
Dried brewers' grains,	1	2	62—62 62	- -	50—55 53	89—93 91	78—81 79	59—59 59
Corn cobs,	1	2	59—60 59	- -	65—66 65	44—56 50	13—22 17	60—60 60
II. EXPERIMENTS WITH SWINE.								
Maize kernels (whole),	1	1	83	83	83	46	69	89
Maize meal,	2	2	89.5—89.7 90	91.3—92.1 92	29.4—48.7 39	77.6—81.7 80	86.1—89.9 88	93.9—94.2 94
Maize meal (with cobs),	1	1	76	77	29	82	76	84
Pea meal,	1	1	90	92	78	50	89	95
Barley meal,	1	1	80	80	49	57	81	87
Wheat shorts,	1	2	74—79 77	- -	25—48 37	- -	71—75 73	85.5—88 87
Wheat bran,	1	2	53.7—68.6 61	- -	29.6—39.1 34	65.4—78.1 72	74.4—75.8 75	56—75 66

LITERATURE.

The following publications have been consulted in compiling the tables of the digestibility of American feed stuffs: —

Reports of the Maine State Experiment Station for 1886, 1887, 1888, 1889, 1890, 1891, 1893.

Reports of the New York Experiment Station, 1884, 1888, 1889.

Reports of the Pennsylvania Experiment Station, 1887, 1888, 1889, 1890, 1891, 1892, 1893.

Bulletins 87 *d*, 80 *c*, 81 and 97 of the North Carolina Experiment Station.

Bulletin No. 16, Utah Experiment Station.

Bulletin No. 3 of the Wisconsin Experiment Station for 1884, and Sixth Annual Report, 1889.

Bulletin No. 8 of the Colorado Experiment Station.

Bulletin No. 26 of the Minnesota Experiment Station.

Bulletin No. 6 of the Oregon Experiment Station.

Bulletins Nos. 13, 15 and 19 of the Texas Experiment Station.

Bulletin No. 20 of the Maryland Experiment Station.

Eleventh and Twelfth Annual Reports (1893 and 1894) of the Massachusetts State Experiment Station.

METEOROLOGY.

C. H. JOHNSON.

1894.

The meteorological observations have been continued as in previous years. The temperature, the force and the direction of the wind and the amount of cloudiness, are recorded each day, at 7 A.M., 2 P.M. and 9 P.M. During the summer months the reading of a wet-bulb thermometer takes place at the same time. Records are also taken of maximum and minimum temperatures, rainfall, and of casual meteorological phenomena.

Monthly and annual reports are sent to the headquarters of the New England Weather Service at Boston.

The most conspicuous meteorological phenomena of the past year (1894) will be briefly considered here, while the following tables will show the average monthly temperature, precipitation, prevailing direction of the wind, etc.

The mean temperature for January, February and March, viz., 28.03°, was above the normal, and 6.15° above that for the first three months of 1893. The precipitation, viz., 6.28 inches, was about 4 inches below normal, and 5.59 inches below that for the same season in 1893.

There were 4 inches of snow on the ground at the beginning of the year, but this had nearly all disappeared by the 15th of January. On the 27th of January 5 inches of snow fell, and on the 29th and 30th there was a storm giving 10 inches, so there were 13 inches of snow on the ground at the end of the month.

The daily mean temperature for January, viz., 25.43°, was about 5° above the normal, and was 10.95° above that of January, 1893, as recorded at this station. The precipitation was much below the normal.

The mean temperature for February, viz., 19.68°, was about 4° below the average. On the morning of the 25th the minimum reading was — 18°. The mean temperature for the 24th was — 1° and for the 25th — 2.5°, these being the two coldest days of the year. The precipitation was much below the normal, but the ground was well protected with snow during the greater part of the month.

The month of March was warm and dry. The daily mean temperature, viz., 39°, was nearly 10° above the normal, and was 9.4° above that of March, 1893. The precipitation, viz., 1.68 inches, was nearly 2 inches below the average.

April was also characterized by being unusually warm and pleasant. The daily mean temperature, viz., 45.6°, was about 2° above the normal. The precipitation, viz., 1.60 inches, was 2 inches below the average for that month. There was a storm on the 8th giving 4 inches of snow, and one on the 12th and 13th giving 2 inches. This was the last snowfall of the season. April being so warm and dry, farmers were enabled to get most of their land in condition for planting, and some had planted potatoes, onions, mixed forage crops, etc., by the 25th.

The mean temperature for May was about the average. The mercury reached the freezing point several times. On the morning of the 15th the minimum reading was 28°. The precipitation was about normal, but most of it occurred during the last week of the month. The dry weather during the first two weeks of the month retarded the germination of seeds and growth of plants. Frosts on the 15th and 22d injured those crops that were up, and damaged fruit, especially on low lands. The frost of the 22d was the last of the season.

The mean temperature for June, viz., 67.53°, was about 3° below the normal. The rainfall was 5 inches below the average, and most of it occurred during the first and last part of the month, while the middle was hot and dry. The month was favorable for the growth of all crops. Haying was quite general by the 15th.

The month of July was hot and dry. The daily mean temperature, viz., 71.9°, was about 4° above the normal, while the rainfall, viz., 1.60 inches, was nearly 3 inches below, and 1 inch below that for July, 1893. The absolute maximum temperature was 98°, occurring on the 20th.

August was extremely dry. The mean temperature was about normal, while the precipitation, viz., 32 inches, was nearly 4 inches below.

The continued drought of July and August caused great damage to farmers, seriously injuring crops; drying up wells and springs, so that in many instances the water supply was almost or entirely shut off.

The first frost of the season occurred on the 22d of August, and slightly injured vegetation on low lands.

The mean temperature for September and October was about 3° above normal, and the rainfall about normal. These months were favorable for the ripening and harvesting of crops.

The mean temperature for November was about normal, while the precipitation was 5 inches below. A trace of snow fell on the 5th, which was the first of the season.

For December the mean temperature was about normal, while the precipitation was slightly below.

The precipitation has not been sufficient to fill up the wells and springs, and now there is a scarcity of water in many localities.

Summary of Meteorological Observations, 1894.

	TEMPERATURE, DEGREES FAHRENHEIT.														
	7 A M.	2 P.M.	9 P.M.	Mean Maximum.	Mean Minimum.	Mean.	Absolute Maximum.	Date.	Absolute Minimum.	Date.	Greatest Daily Range.	Date.	Least Daily Range.	Date.	Mean Daily Range.
January, ...	21.13	30.83	25.64	34.84	16.39	25.43	45.00	22d	0	29th	34.00	2d	6.00	5th	18.45
February, ...	16.93	28.53	21.64	30.93	8.85	19.68	46.00	8th	—18.00	25th	47.00	17th	10.00	9th	22.08
March, ...	34.54	47.64	38.00	49.51	28.48	39.00	73.00	19th	20.00	4th, 26th	32.00	18th	11.00	14th, 29th	21.03
April, ...	41.63	55.00	44.76	56.80	34.40	45.60	77.00	27th	14.00	3d	40.00	16th	5.00	8th	22.40
May, ...	52.48	66.42	54.03	69.48	43.45	56.45	84.00	1st, 2d	28.00	15th	42.00	14th	10.00	31st	26.03
June, ...	63.76	76.90	65.76	79.20	55.86	67.53	93.00	17th	37.00	8th	39.00	14th	11.00	29th	23.34
July, ...	67.50	82.00	70.40	84.80	59.10	71.90	98.00	20th	48.00	10th, 11th, 23d	34.00	23d	14.00	5th	25.70
August, ...	61.40	78.30	65.10	80.40	53.50	66.90	91.00	24th	36.00	22d	42.00	22d	9.00	30th	26.90
September, . . .	57.16	73.10	62.30	76.00	51.46	63.73	91.00	10th	32.00	26th	40.00	13th	8.00	19th	24.53
October, ...	45.70	58.90	48.30	60.20	40.40	50.30	73.00	20th	29.00	19th	33.00	20th	5.00	25th	19.87
November, . . .	31.80	39.46	33.46	41.70	25.83	37.10	65.00	3d	9.00	20th	27.00	2d	6.00	8th, 9th	15.86
December, . . .	21.48	32.93	24.84	34.67	15.64	25.16	49.00	15th	—7.00	28th, 30th	36.00	6th	6.00	8th, 9th, 12th	19.03
Sums, . . .	515.51	670.01	554.23	698.58	433.36	569.78	-	-	-	-	-	-	-	-	265.22
Means, . . .	42.98	55.83	46.18	58.21	36.11	47.48	-	-	-	-	-	-	-	-	22.10

Summary of Meteorological Observations, 1894.

	PRECIPITATION, INCHES.					WIND.	CASUAL PHENOMENA.—DATES.			
	Total Amount.	Date of Greatest Fall.	Total Snowfall.	Depth of Snow the 15th.	Depth of Snow at End of Month.	Prevailing Direction.	Thunder-storms.	Solar Halos.	Lunar Halos.	Aurora.
January,	2.43	29, 30,	20.20	.50	13.00	N. W. and N.	- -	9, 15, 26,	18,	8,
February,	2.17	9, 10,	18.25	13.00	5.00	N. W.	- -	5, 12, 17, 25,	14, 17, 18, 20,	22, 23,
March,	1.68	22, 23,	2.00	2.00	-	S. W.	- -	12, 13, 15, 20, 22,	12, 20,	2, 30,
April,	1.60	21, 22,	6.00	3.00	-	N.	27, 28,	1, 16, 30,	16, 18,	-
May,	3.80	18, 19,	-	-	-	S. W.	2, 6, 18, 19,	14, 16,	16,	-
June,	3.43	2, 3,	-	-	-	S. W.	18, 19, 27, 30,	-	14,	-
July,	1.60	21, 22,	-	-	-	S. W. and S.	3, 4, 6, 14, 17, 21, 25, 29,	-	22,	-
August,	.32	3,	-	-	-	S.	3, 15, 19, 30,	-	-	-
September,	4.11	19, 20,	-	-	-	S.	10, 16, 20,	-	-	-
October,	4.40	9, 10,	-	-	-	S.	- -	-	-	-
November,	3.09	3,	3.00	-	-	N.	- -	-	-	-
December,	3.45	11, 12,	22.00	-	7.00	N.	- -	19, 24, 26,	7, 10, 19,	-
Sums,	32.08	-	71.45	-	-	-	- -	-	-	-

SUMMARY OF METEOROLOGICAL OBSERVATIONS, 1894.

January, February, March, April.

	1893.	Date.	1894.	Date.
Mean temperature, ...	26.89°	-	32.43°	-
Absolute maximum temperature, . . .	66.00°	April 1,	77.00°	April 27.
Absolute minimum temperature, . . .	—13.00°	Jan. 17,	—18.00°	Feb. 25.
Mean monthly range, ...	19.34°	-	20.99°	-
Total precipitation (inches), ...	15.53	-	7.88	-
Total snowfall (inches), ...	71.25	-	46.45	-
Last snowfall (inches), ...	trace	April 21,	2.00	April 12.

May, June, July, August.

	1893.	Date.	1894.	Date.
Mean temperature, ...	64.47°	-	65.69°	-
Absolute maximum temperature, . . .	94.00°	Aug. 10,	98.00°	July 20.
Absolute minimum temperature, . . .	31.00°	May 8,	28.00°	May 15.
Mean monthly range, ...	24.12°	-	25.52°	-
Last frost, ...	-	May 8,	-	May 22.
Total precipitation (inches), ...	13.38	-	9.15	-

September, October, November, December.

	1893.	Date.	1894.	Date.
Mean temperature, ...	42.29°	-	44.07°	-
Absolute maximum temperature, . . .	81.00°	Sept. 10,	91.00°	Sept. 10.
Absolute minimum temperature, . . .	—13.00°	Dec. 14,	—7.00°	Dec. 28, 30.
Mean monthly range, ...	21.82°	-	19.25°	-
First frost, ...	-	Sept. 8,	-	Aug. 22.
Total precipitation (inches), ...	14.31	-	15.05	-
First snowfall (inches), ...	trace	Nov. 4,	trace	Nov. 5.
Total snowfall (inches), ...	15.25	-	25.00	-

Entire Year.

	1893.	Date.	1894.	Date.
Mean temperature, ...	44.55°	-	47.39°	-
Total precipitation (inches), ...	43.22	-	32.08	-
Total snowfall (inches), ...	86.50	-	71.45	-

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Mirror and Farmer, Manchester, N. H.
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American Agriculturist, New York, N. Y.
The Florists' Exchange, New York, N. Y.
Vick's Magazine, Rochester, N. Y.
The American Analyst, New York, N. Y.
Naturalist Monthly Bulletin, Philadelphia, Pa.
The Practical Farmer, Philadelphia, Pa.
The Farm Journal, Philadelphia, Pa.
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